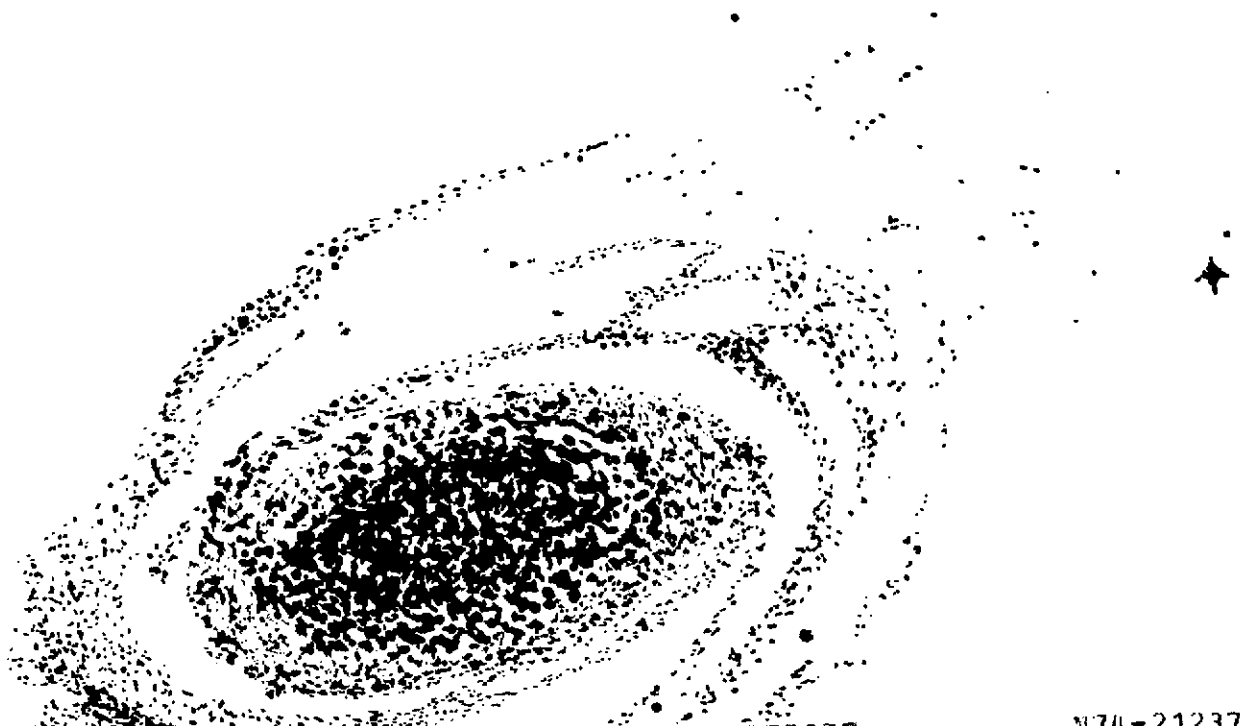


A METEOROLOGICAL REPORT FOR THE MT. HOPKINS OBSERVATORY: 1968-1971

M. R. PEARLMAN, D. HOGAN, K. GOODWIN,
and D. KURTENBACH



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A METEOROLOGICAL REPORT FOR THE MT. HOPKINS
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DeWayne Kurtenbach

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Astrophysical Observatory
Cambridge, Massachusetts 02138

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ABSTRACT

This document is a compilation of the weather data collected at the Mt. Hopkins Observatory in southern Arizona from 1968 to 1971. It is the second meteorological report aimed at assisting scientists in the scheduling of experiments at the Observatory site. The first two years of data were published in SAO Special Report No. 327. Conclusions from these data must be drawn in relation to the interest of the individual investigator.

RESUME

Ce document est une compilation des données météorologiques recueillies à l'observatoire du Mont Hopkins en Arizona du Sud de 1968 à 1971. C'est le second rapport météorologique visant à aider les savants à prévoir les expériences à faire au site de l'observatoire. Les données des deux premières années ont été publiées dans le rapport N^o 327 du SAO. Il faut tirer les conclusions de ces données en fonction de l'intérêt de chaque chercheur.

КОНСПЕКТ

Эта статья является сборником данных о погоде полученных в Гопкинс Обсерватории в южной Аризоне с 1968г по 1971г. Она является вторым метеорологическим отчетом подготовленным с целью предоставления помощи ученым при составлении расписания опытов на местоположении обсерватории. Данные за первые два года были опубликованы в Специальном Отчете САО №327. Выводы основанные на этих данных должны быть сделаны в соответствии с интересом отдельного исследователя.

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A METEOROLOGICAL REPORT FOR THE MT. HOPKINS

OBSERVATORY: 1968-1971

Michael R. Pearlman, Donald Hogan, Kenneth Goodwin,
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1. METEOROLOGICAL MEASUREMENTS

From 1968 to 1971, weather data were collected at SAO's Mt. Hopkins Observatory in southern Arizona. Data from the first two years were published in SAO Special Report No. 327. This report includes those data as well as new data collected during 1970 and 1971. Figure 1 shows a topographic map of the area.

Temperature and humidity measurements (see Figures 2 to 4) were taken hourly on knoll #2 with a continuous-reading Bendix Friez Instrument Hygrothermograph Model 594. Calibrations were made periodically with a Taylor mercury thermometer and a U.S. Weather Bureau thermometer. The estimated measurement accuracy was $\pm 1^\circ\text{F}$. The humidity system was calibrated at least once a week with a Taylor sling psychrometer. The accuracy of relative-humidity measurements was estimated to be about 5%.

Values for dew point (see Figures 5 and 6) and absolute humidity (see Figures 7 and 8) were determined from the hourly temperature and relative-humidity data. Saturation vapor pressures were calculated from an analytic expression, based on the Smithsonian Meteorological Tables,^{*} supplied by Dr. Gordon D. Thayer of the National Oceanic and Atmospheric Administration. Water-vapor densities were derived from formulas available in the meteorological tables.

This work was supported in part by contract NAS 12-2129 from the National Aeronautics and Space Administration and grant SG 220004 from the Smithsonian Research Foundation.

^{*} Smithsonian Meteorological Tables, 6th revised edition, prepared by R. J. List, Smithsonian Miscellaneous Collections, vol. 114, Washington, D.C., 1951, 527 pp.

The accuracy of the dew-point and absolute-humidity values decreases with decreasing temperature and relative humidity (Table 1). The relative uncertainties are therefore largest when the vapor density is low.

Table 1. Estimate of accuracies.

Temperature (°F)	Relative humidity (%)	Dew point (°F)	Absolute humidity (%)
80	75	±3	±18
60	50	±4	±27
40	50	±5	±38
20	25	±8	±75

Precipitation measurements (see Figure 9) were made with a conventional rain gauge, with readings taken during and after periods of precipitation. Measurement accuracy was about ± 0.01 inch.

Hourly barometric-pressure measurements (Figure 10) for the period July 1969 to December 1971 were made on knoll #2 with a U.S. Signal Corps Barograph ML-3-D. The instrument was calibrated once a week with a U.S. Weather Bureau aneroid barometer. Measurement accuracy was about ± 0.01 inch.

Before July 1969, barometric-pressure readings were taken twice daily on knoll #3 with a Friez & Co., Baltimore, circular-face aneroid barometer.

Wind speed and direction (see Figures 11 to 15) were measured on knoll #1 with a continuous-reading Bendix Friez Instrument Aerovane Wind Recorder (Model 141). Readings were taken hourly, along with daily maximum wind speed and direction. Speed measurements were accurate to about ± 1 mph. Wind direction was rounded off to the nearest compass direction (in $22\frac{1}{2}$ intervals) before calculations were performed. Wind measurements were also made at the peak with a similar instrument for the period July to December 1969. Correlations of the wind speeds (see Figure 11) and wind directions (see Figure 16) have been included. It should be recognized, however, that the wind speed and direction can vary greatly with location on the peak and that these data may characterize conditions only over a small region.

Nighttime cloud cover (see Figures 17 to 20) was taken visually four times a night by observers. Starting in July 1971, star trails were recorded on film for cloud-cover estimates. This information was classified as clear, partly cloudy, or cloudy before calculations were performed. Clear nights are those in which clear skies (0 to 20% cloud cover) were observed during three of the four observations and conditions were no worse than partly cloudy (30 to 70%) during the fourth. Cloudy nights are those in which the sky was cloudy (80 to 100%) during at least two of the four observations. General meteorological conditions were also recorded during the four nightly observations (Figure 21).

Daytime cloud cover (Figures 22 to 25) was recorded continuously at the summit with a sol-a-meter, an instrument for measuring solar energy, supplied by Dr. Nelder Medrud of the High Altitude Observatory at the National Center for Atmospheric Research in Boulder, Colorado. Dr. Medrud reduced the data and performed the necessary statistical analyses.

Cloud-cover correlation data (see Figures 26 and 27) have been compiled from the cloud-cover observations, and estimates extracted from the daytime sol-a-meter recorded data. The pertinent information in this analysis is the predictability of nighttime cloud cover from observations made during the day.

2. WEATHER PATTERN

The yearly weather pattern at Mt. Hopkins can be divided into periods that correspond closely to the calendar seasons. The patterns discussed here are based on observations from 1968 through 1971 and are very similar to those from the 1968-1969 data published in SAO Special Report No. 327.

Spring

From mid-March to June, the spring season is characterized by clear skies and very low precipitation. Clear afternoon skies appear to be an excellent indicator of clear nights to follow; similarly, cloudy afternoons generally indicate adverse evening conditions. Some snow storms accompanied by day-long heavy cloud cover occur during March.

The temperature ranges from March lows averaging about 30°F to June highs of about 70°F, with extremes as low as 20°F in March and as high as 90°F in June. Sub-freezing temperatures often occur during the evening in late March, April, and early May. Full 24-hour periods of subfreezing temperatures are rare during this period.

The absolute humidity is on the rise throughout the spring. A typical value for March is 2 g/m³, while June averages about 5 g/m³. Extremes during this period range from well below 1.0 to 15 g/m³. The relative humidity decreases through the spring as a result of the rising temperatures. It is usually below 50% and rarely exceeds 90%.

During the spring, winds at the ridge blow at a fairly steady 10 to 15 mph from a predominantly westerly direction. Maximum wind speeds are not very large except in March, when high winds from the west and northwest accompany occasional snow storms.

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Summer

The summer season, from July through mid-September, is dominated by cloudy, stormy weather with large amounts of precipitation.

Temperatures typically range from 50° to 70°F, with extremes of 90° and 45°F. The absolute humidity averages about 7 g/m³ during this period and may occasionally go as high as 18 to 20 g/m³. It seldom falls below 3 g/m³. The relative humidity averages about 60%, exceeding 50% more than half the time. Conditions of condensation (100% humidity) occasionally occur during the stormy weather. Wind speeds average a fairly steady 5 to 10 mph, with high winds from the east reaching 45 to 50 mph during storms.

Summer storms move in rapidly from the southeast. A typical storm day begins with a clear sky in the early morning; cumulus clouds begin to collect by noontime; and complete overcast prevails by mid to late afternoon. During the late stages of the cloud buildup, the temperature falls by as much as 20°F in as little as 2 hours. A corresponding rise in relative humidity to saturation or near saturation occurs, and the barometric pressure falls rapidly. The wind direction becomes easterly, and wind speed increases. Rainfall begins and continues intermittently into the late evening, after which the skies start to clear. Many storms are accompanied by lightning, which frequently strikes both the peak and the ridge of the mountain. Maximum precipitation during a single storm may amount to 1 to 2 inches. The storm pattern is such that clear skies in the afternoon are still a fair indicator of clear nights to follow.

Fall

The fall, from mid-September to the end of November, is marked by clear skies and low precipitation. Clear daytime skies generally indicate that clear nights will follow.

Temperatures vary from an average daily high in September of 65°F to a typical low in November of 32°F. Extreme temperatures range from highs near 80°F in early fall to lows of about 25°F late in the season. The temperature reaches

freezing or below on 6 to 10 days during November and occasionally in October. The absolute humidity decreases during this time from an average September value of about 7 to about 3 g/m³ in November, with extremes from 15 to 18 g/m³ to well below 0.25 g/m³. The relative humidity averages about 45% and is below 50% about two-thirds of the time. Condensation very rarely occurs. Once the summer storms are over, precipitation is extremely light until winter. An occasional snowfall may occur in November, with some very light snow as early as October.

Wind speeds at the knoll average a steady 5 to 10 mph early in the season and pick up to about 10 to 15 mph during late October and November. In the fall, occasional periods of winds from the north and northeast in excess of 60 mph may last for several days. Comparison of daily wind data for the peak and for the knoll (1968-1969) indicates that the high fall winds at the ridge are largely a function of local conditions and terrain.

Winter

From December to mid-March, winter skies are frequently cloudy. Snow storms from the north and northeast are frequent, with accumulations of 4 to 12 inches, but melting and evaporation are rapid. Afternoon clear skies are a fair indicator of clear nights to follow, but the correlation is not so strong as it is in other seasons. On the other hand, cloudy afternoon skies are a very good indication that a cloudy night will follow.

The temperature during this period averages between 30° and 50° F, with extremes from below 10° to about 70° F. Temperatures go below 32° F on approximately half the days during the winter and remain below freezing for a 24-hour period about a dozen times in the course of the season. The absolute humidity averages about 3 g/m³, with frequent periods in which the vapor content is in the neighborhood of 1 g/m³. Extreme lows of 0.1 to 0.2 g/m³ occur occasionally. Relative humidity averages about 50% during the winter season; however, there are very large differences in conditions from year to year. Condensation occurs quite often, but rain and snow are infrequent.

During December and March, the winds blow at a fairly steady 10 to 15 mph predominantly from the west. In January and February, the winds subside a bit, with a tendency to come from the south and west.

3. ACKNOWLEDGMENTS

We gratefully acknowledge the following for their help during the first two years of data collection: Werner Kirchhoff, Bastiaan Van't Sant, Stephen Rocketto, Paul Clements, Marc Des Tombe, and Richard Schwartz.

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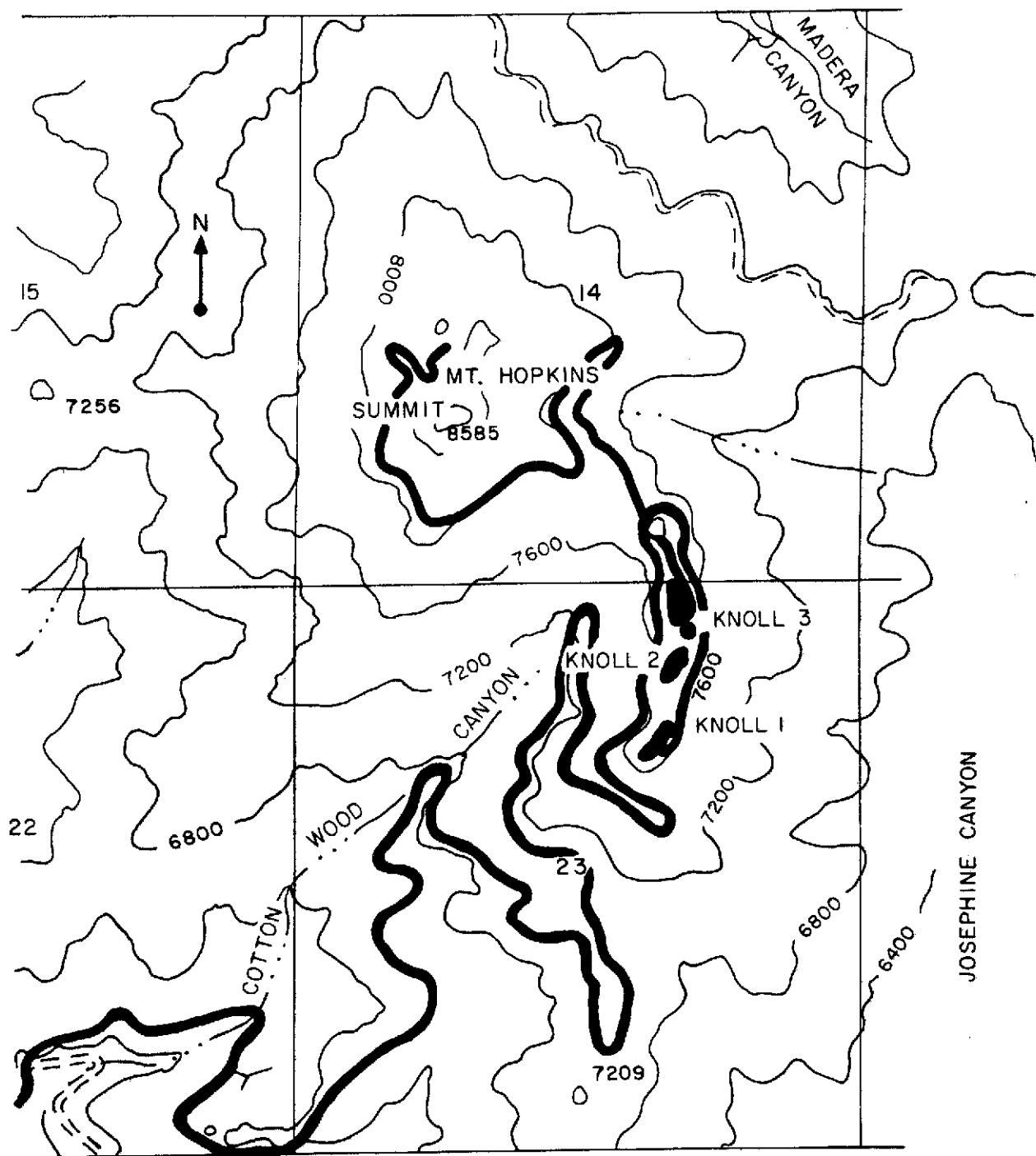


Figure 1. Topographic map of the Mt. Hopkins area. The heavy line represents the access road.

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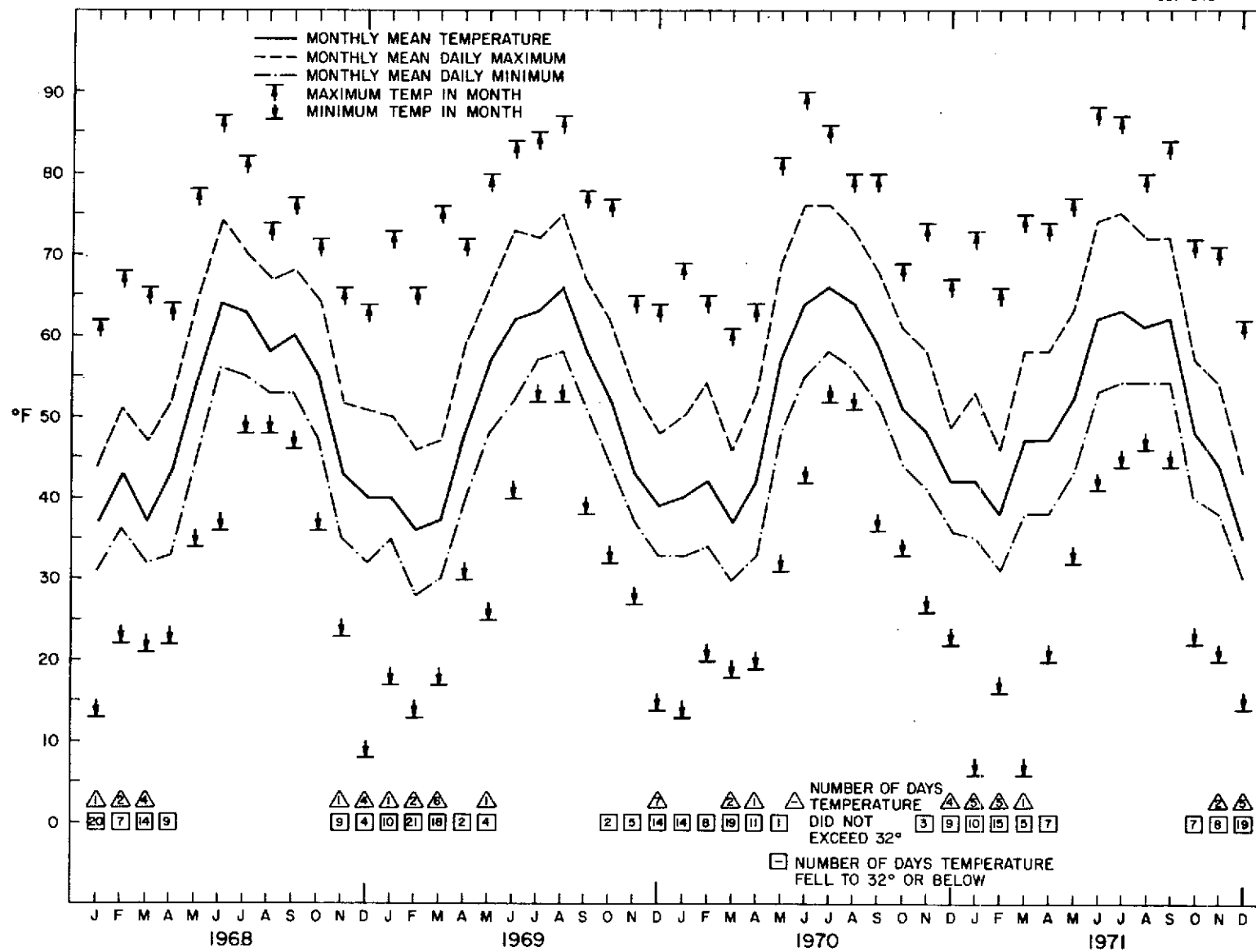


Figure 2. Monthly means and maximum and minimum temperature reading at knoll #2.

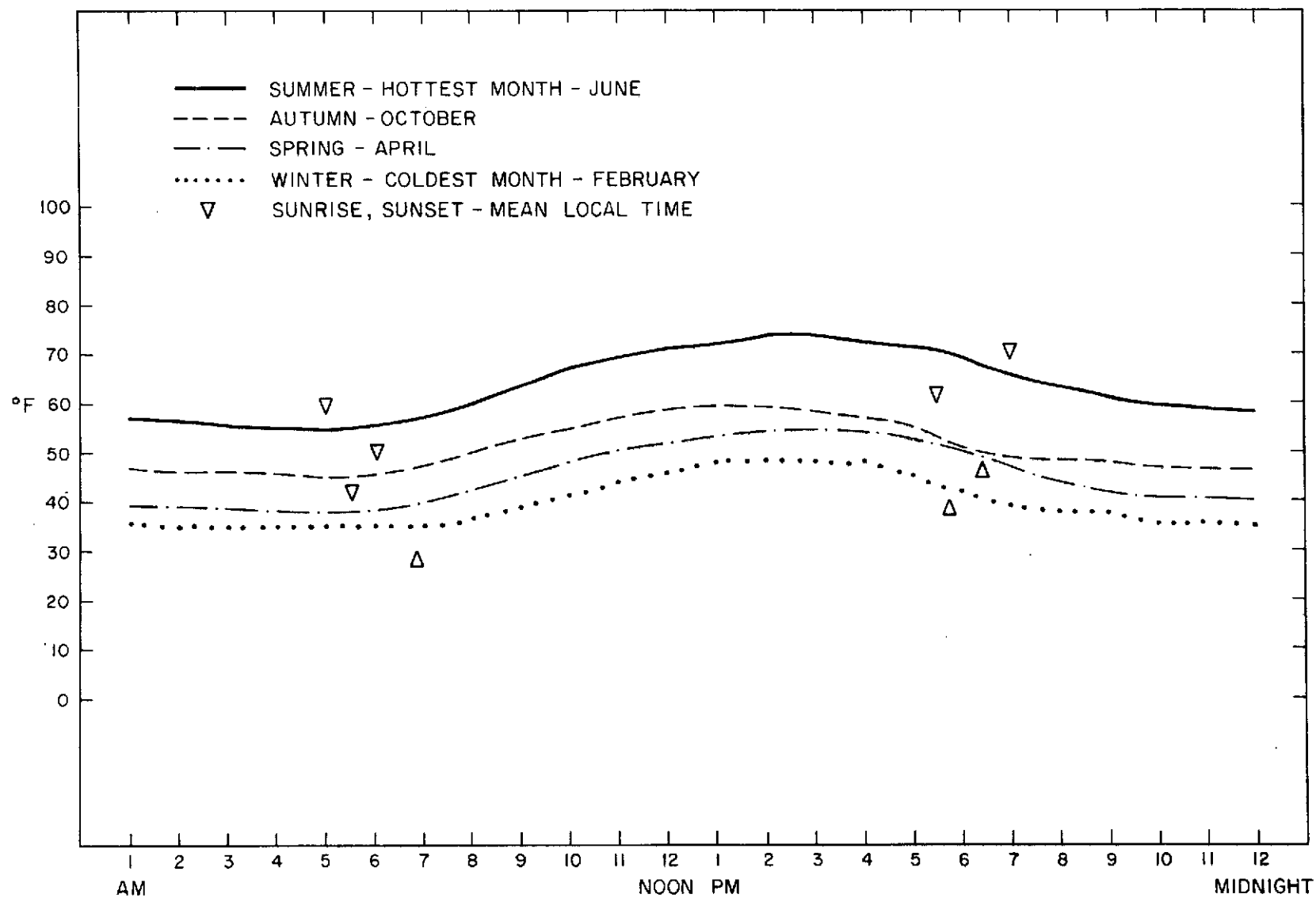


Figure 3. Monthly average hourly temperature (seasonal) at knoll #2, 1968 to 1971.

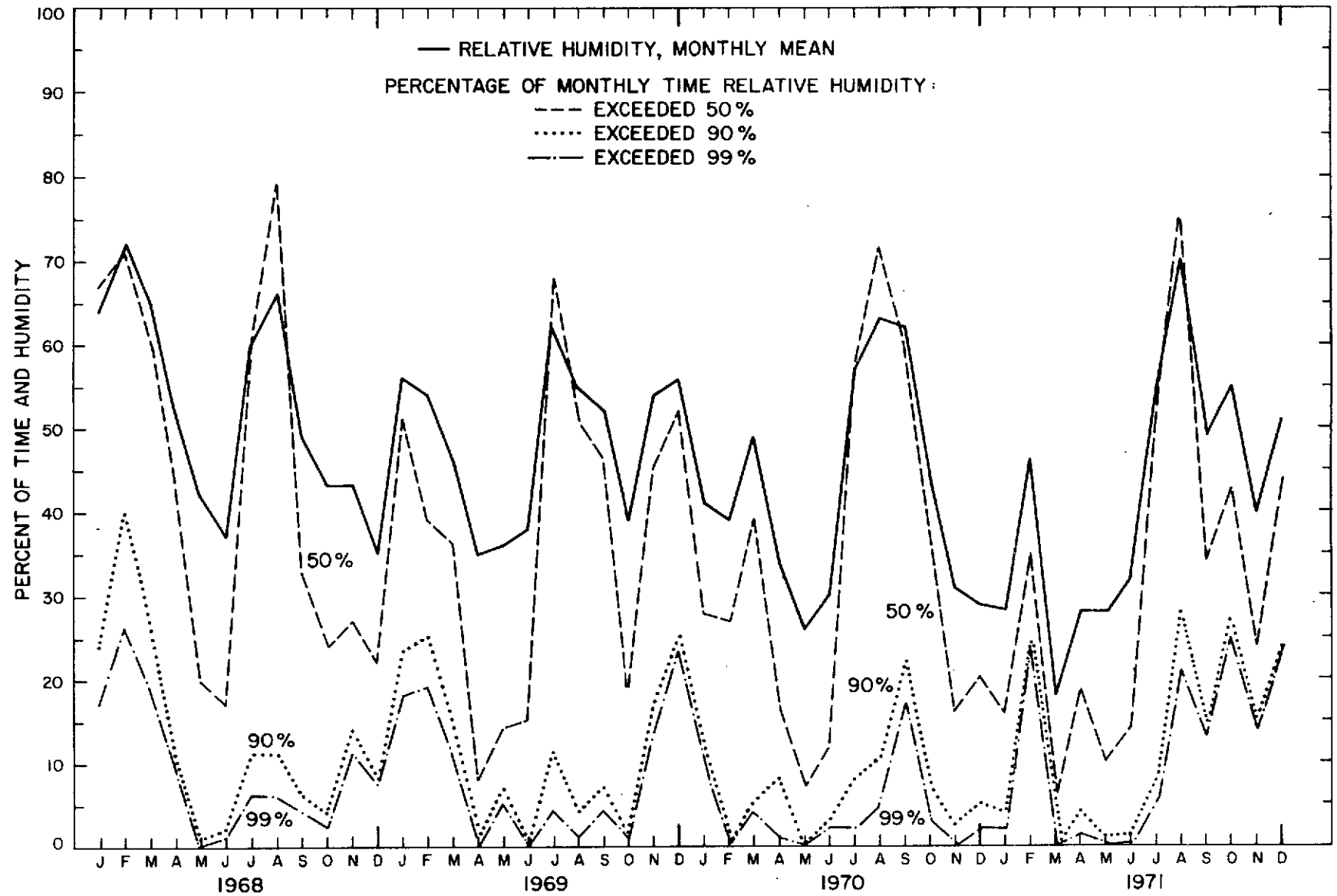
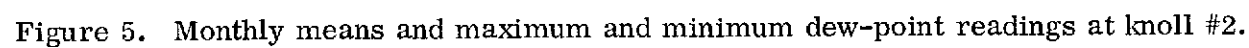


Figure 4. Relative humidity, in monthly percentages, at knoll #2.



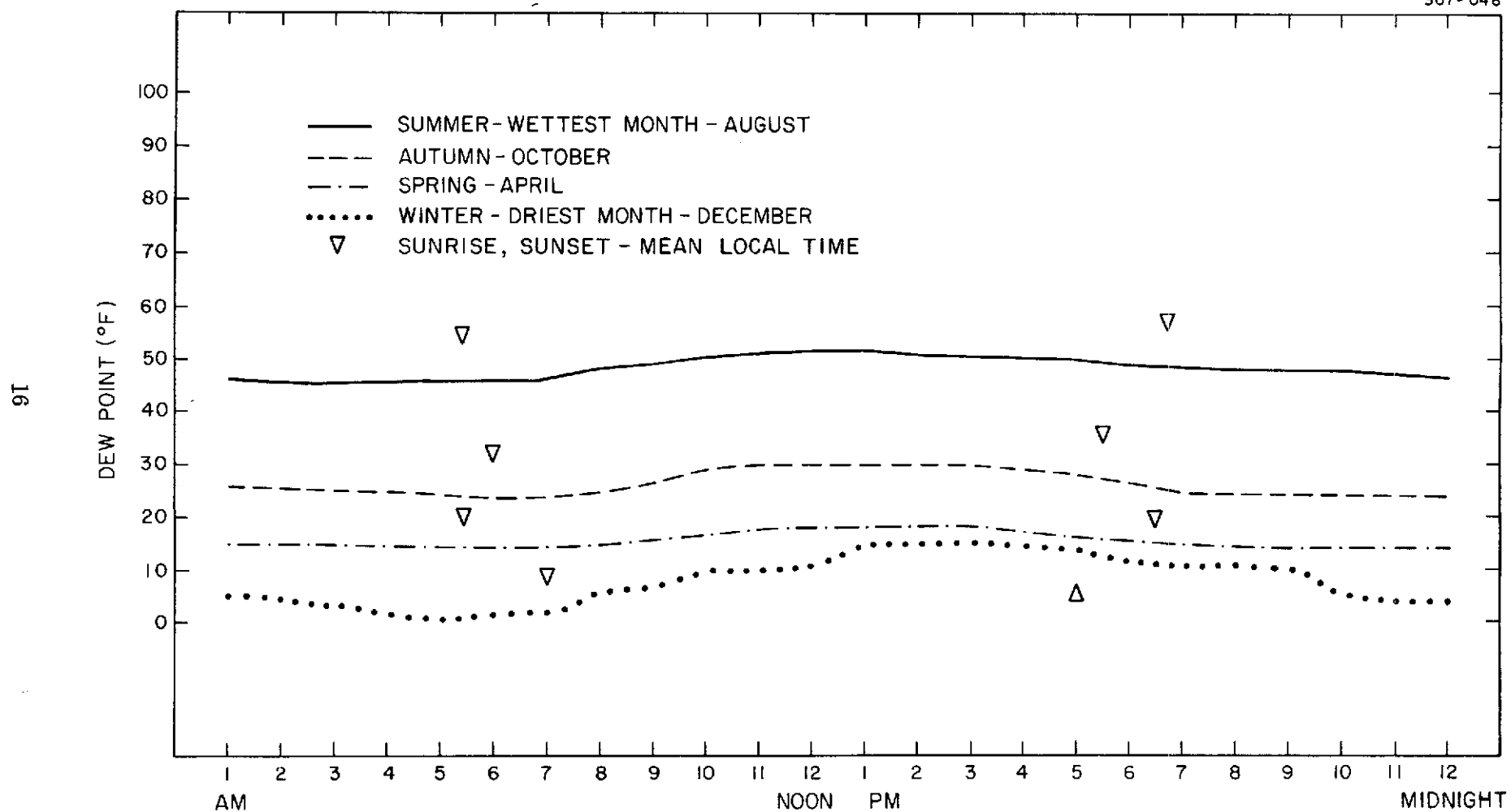


Figure 6. Hourly average of dew point at knoll #2, 1968 to 1971.

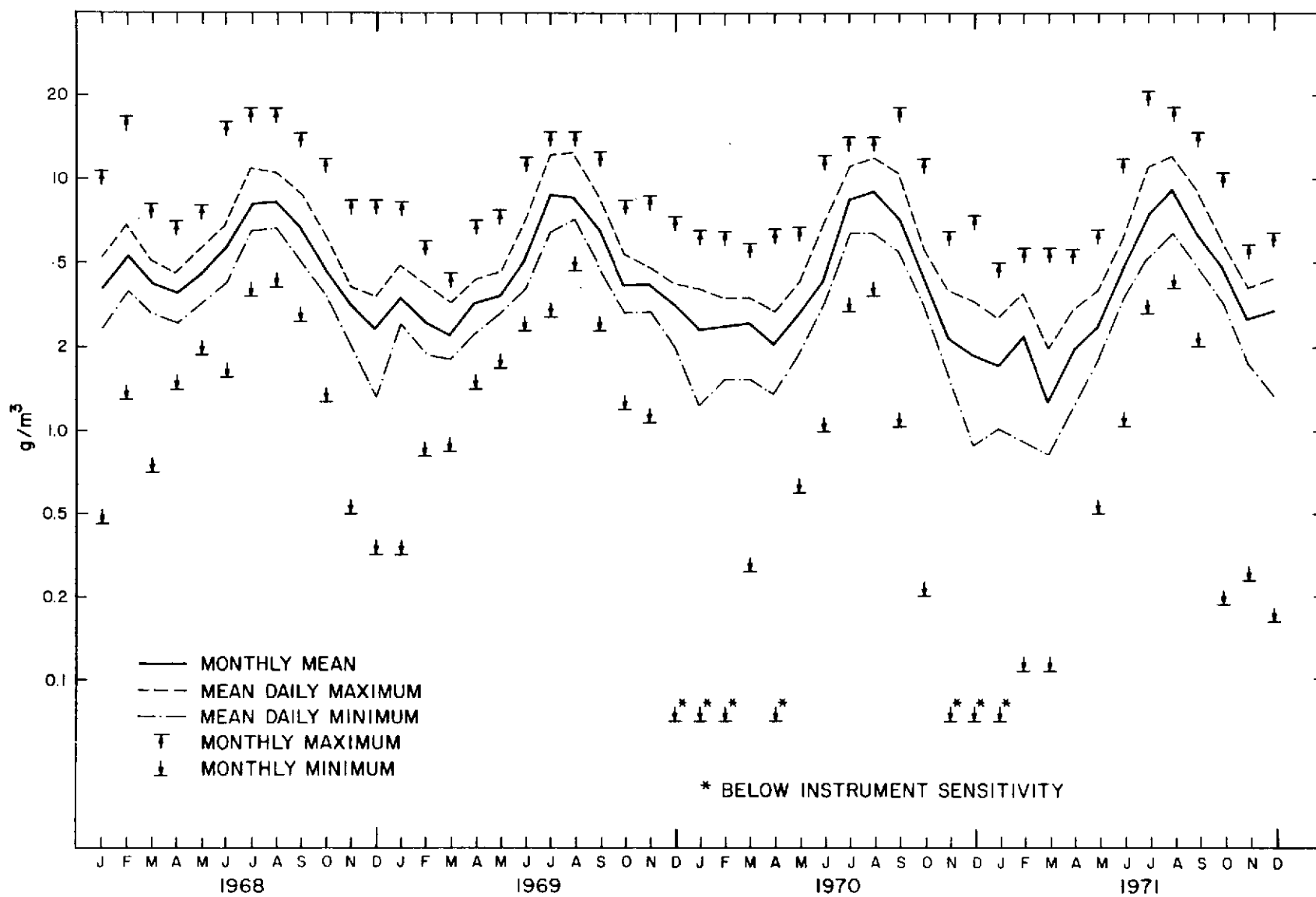


Figure 7. Monthly means and maximum and minimum values of absolute humidity at knoll #2, in g/m³.

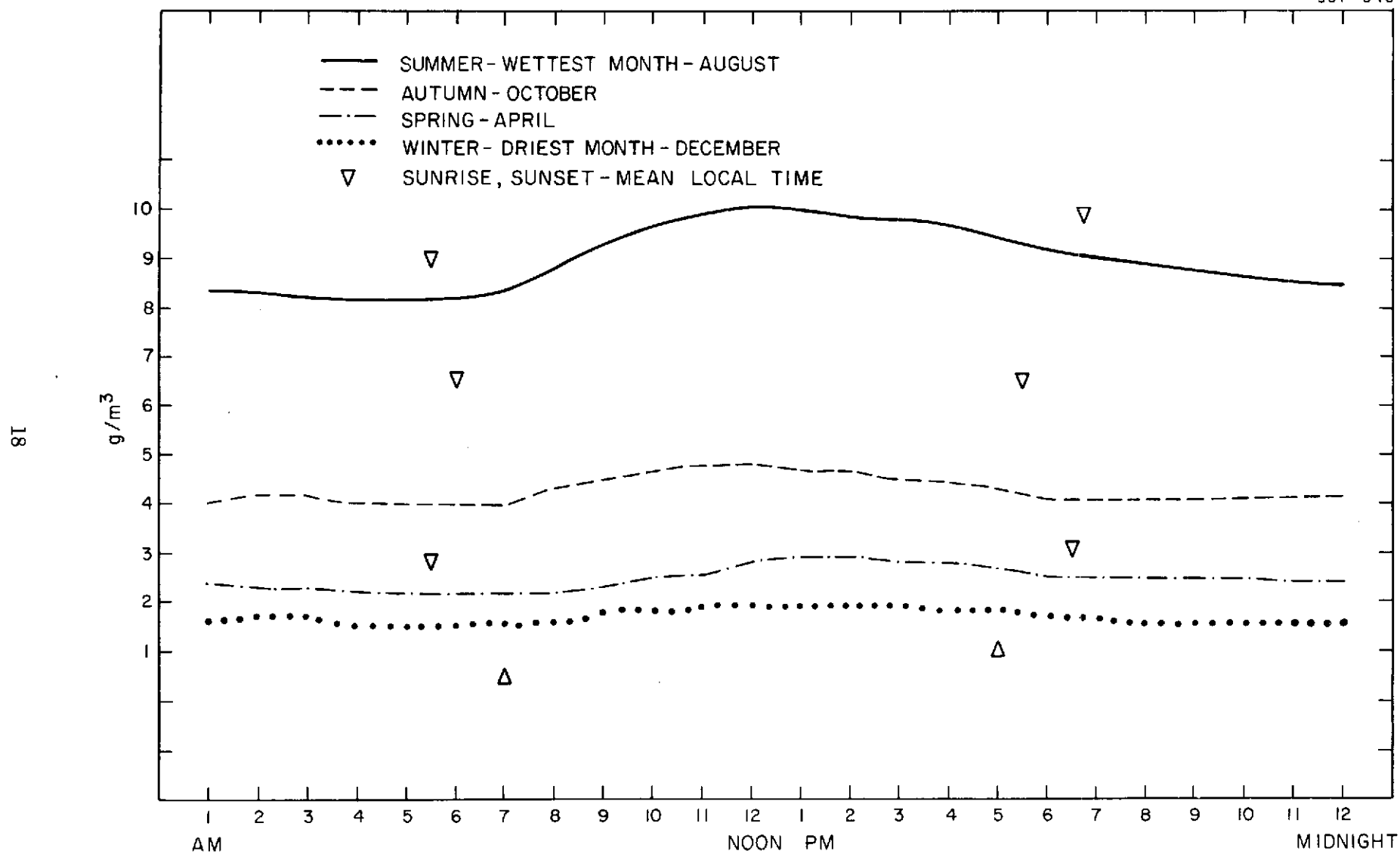


Figure 8. Hourly average of absolute humidity at knoll #2, 1968 to 1971.

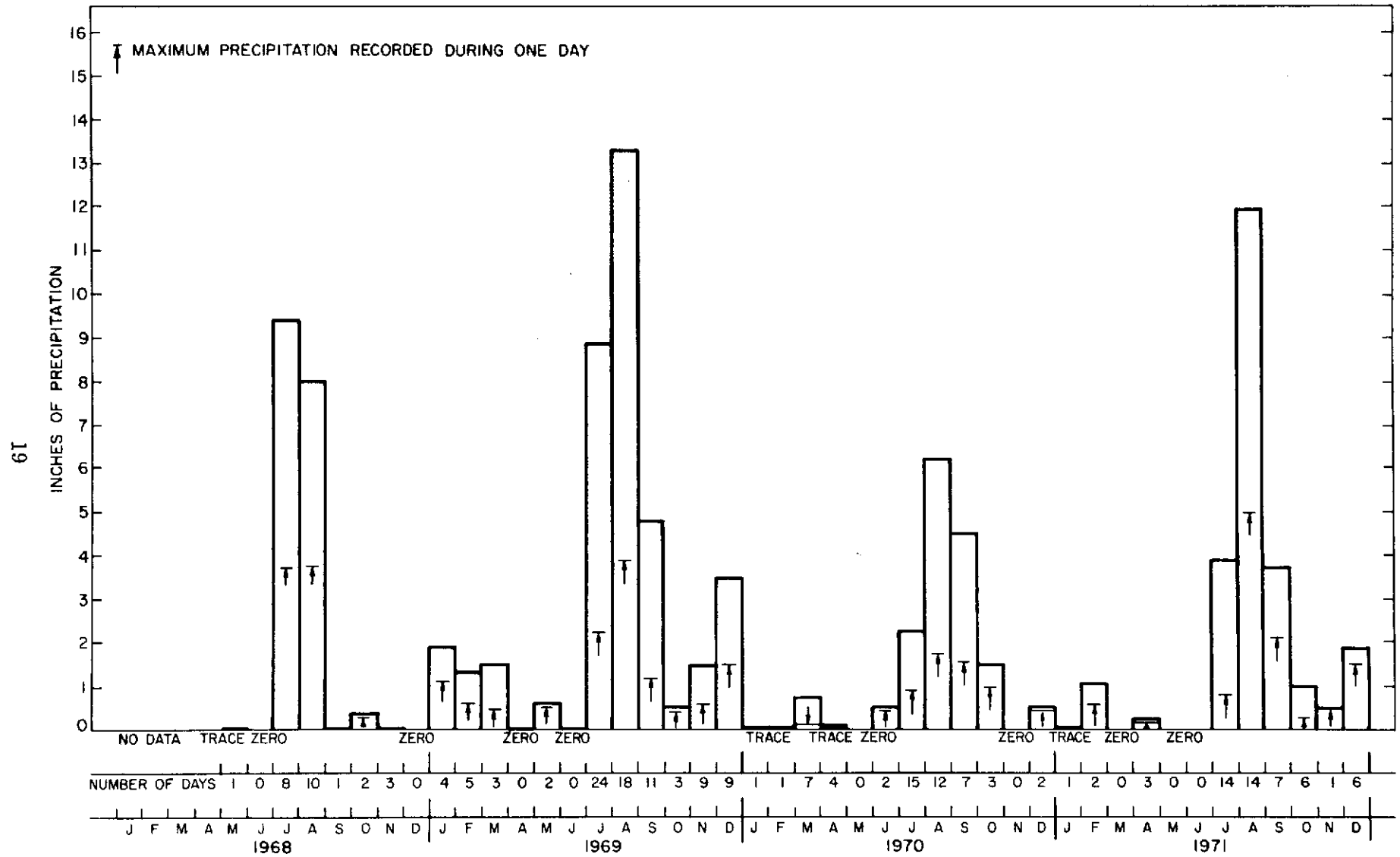


Figure 9. Total monthly and maximum daily precipitation, in inches, and number of days on which rain fell.

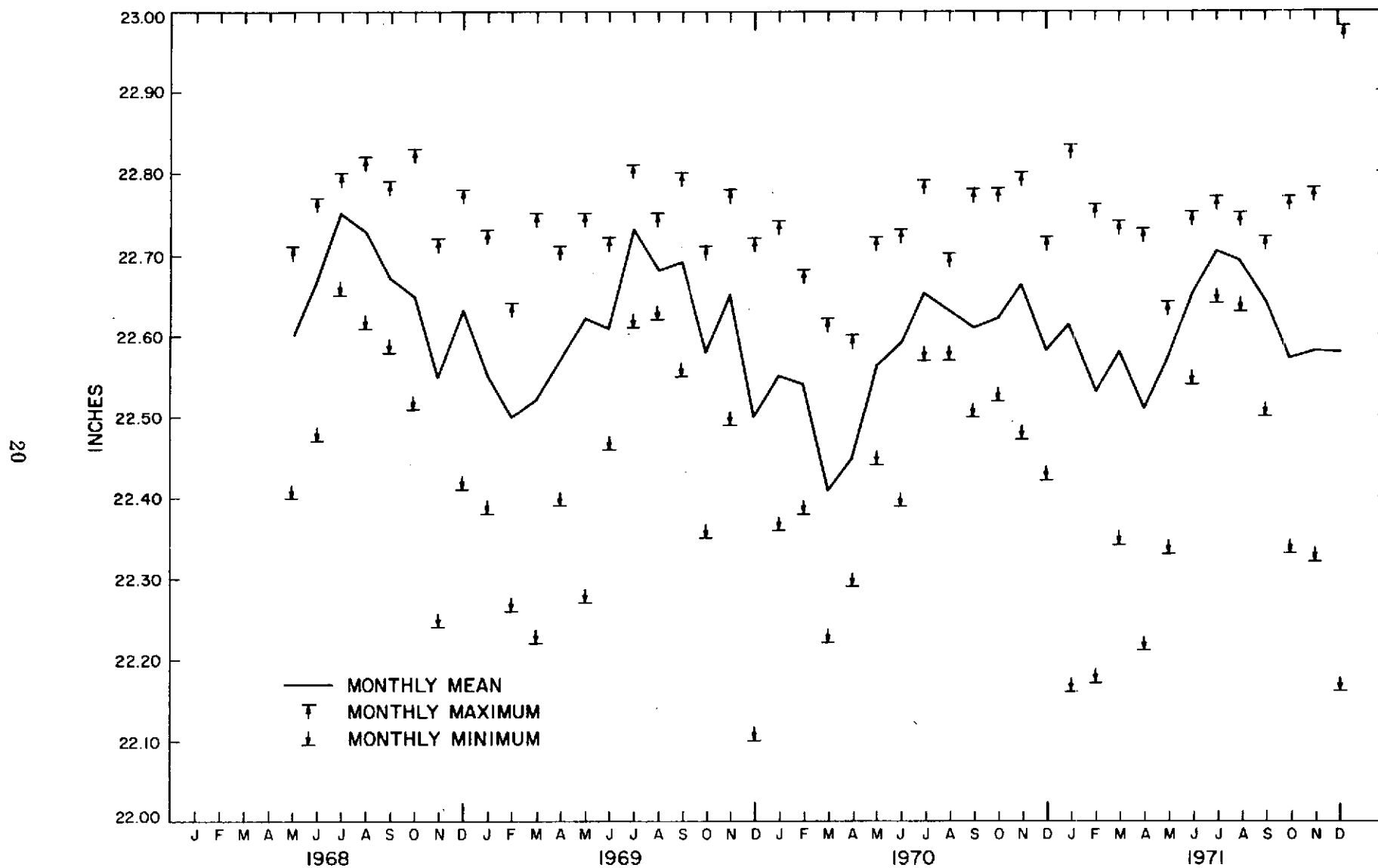


Figure 10. Barometric pressure, in inches, from knoll #2.

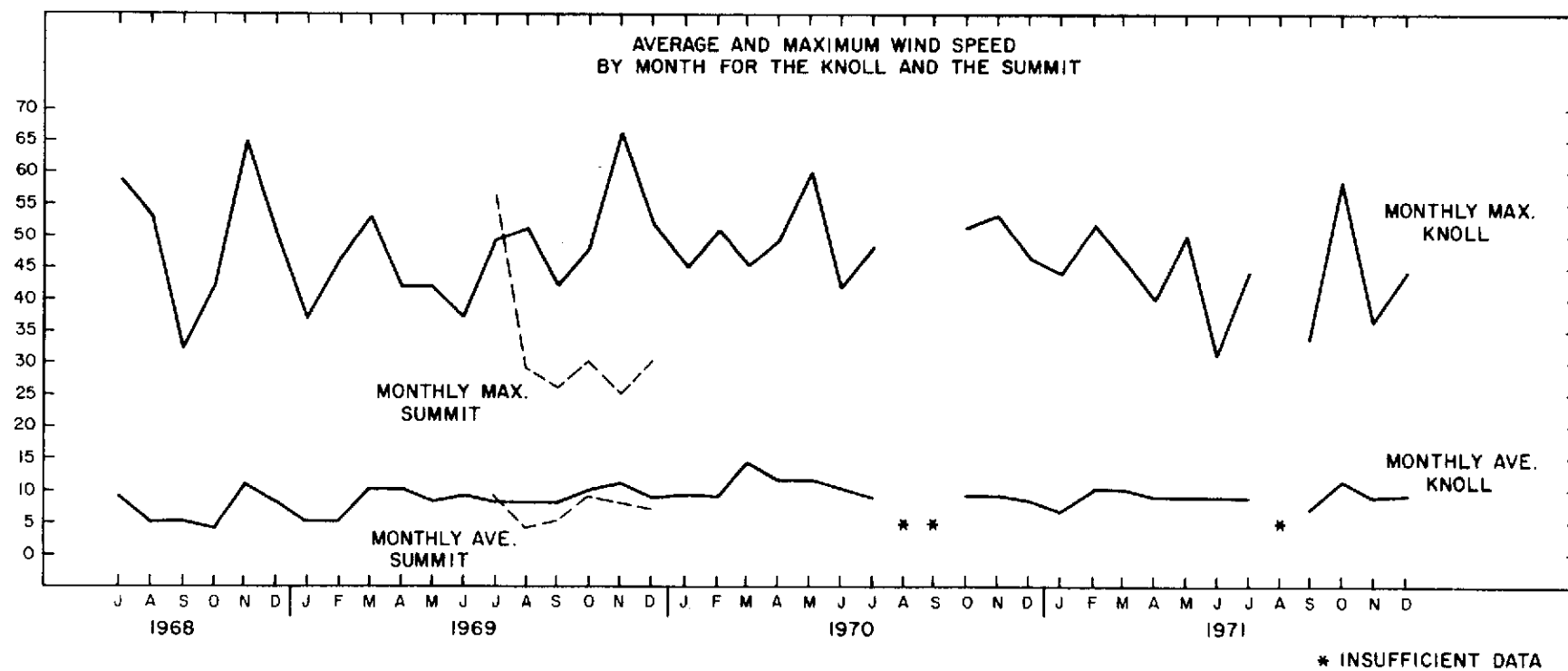


Figure 11. Monthly average and maximum wind speed for knoll #1 and the summit, 1968 to 1969.

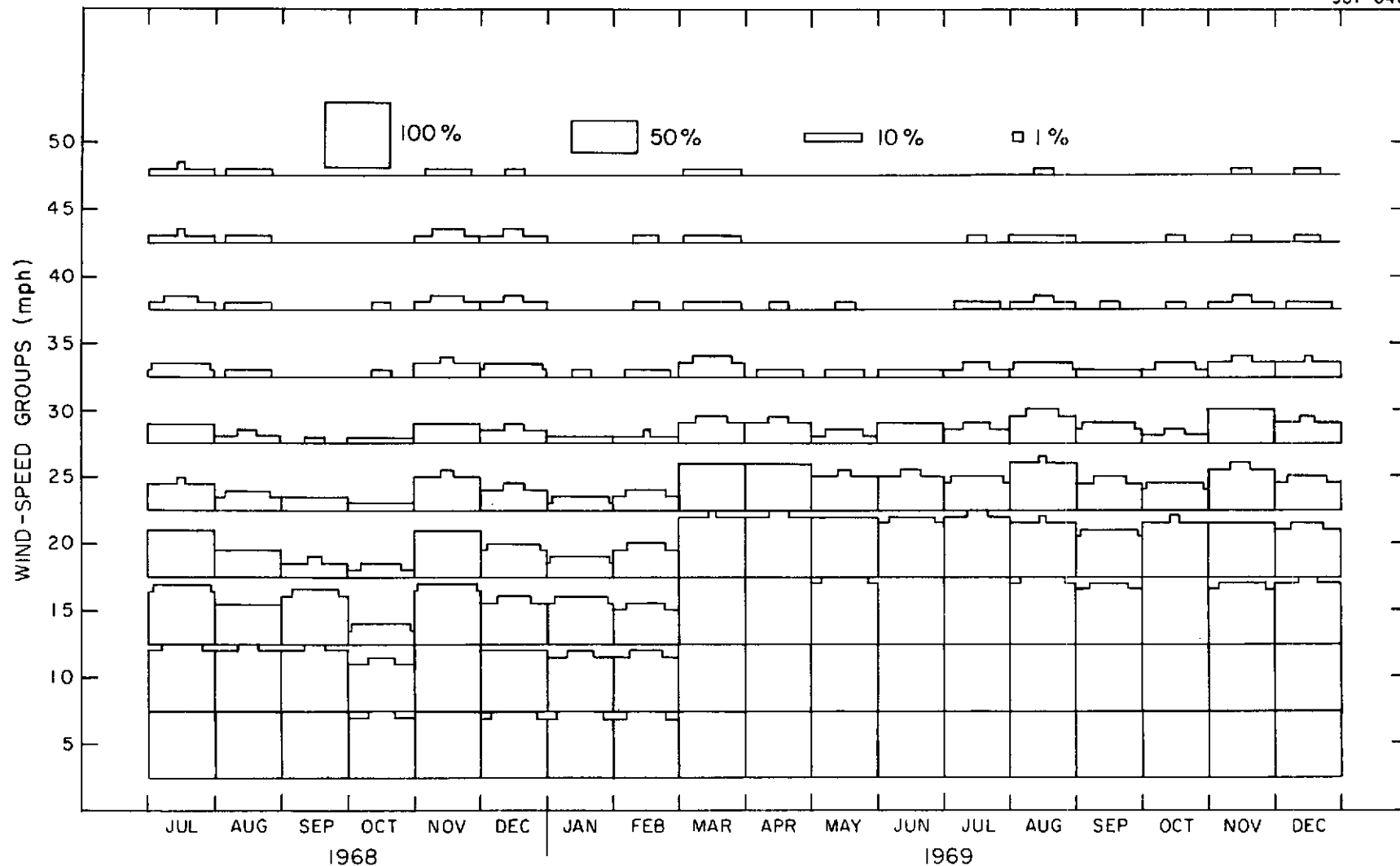


Figure 12. Percent of days the maximum wind speed at knoll #1 exceeded 5-mph incremental wind-speed groups, on a monthly basis.

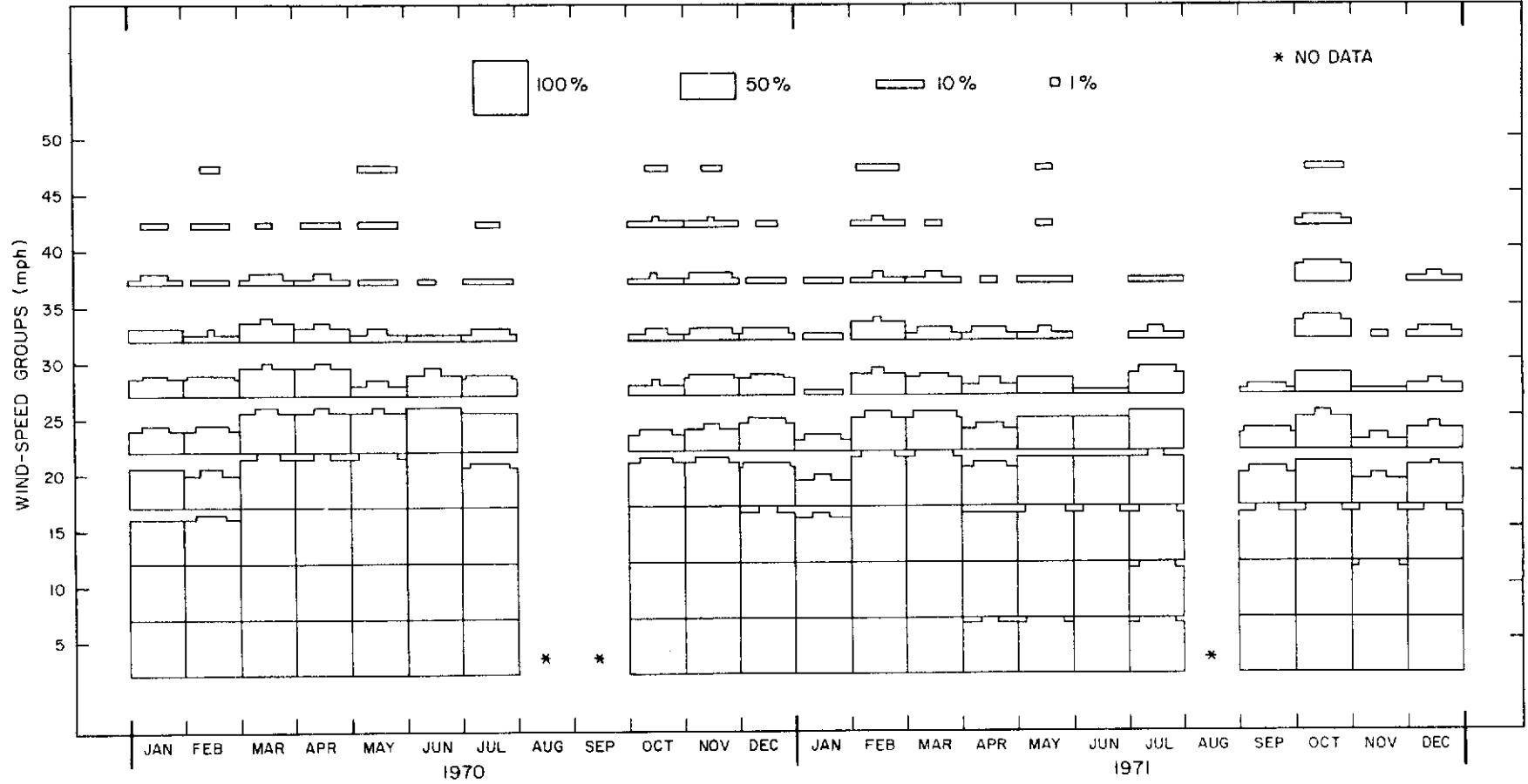


Figure 12 (Cont.)

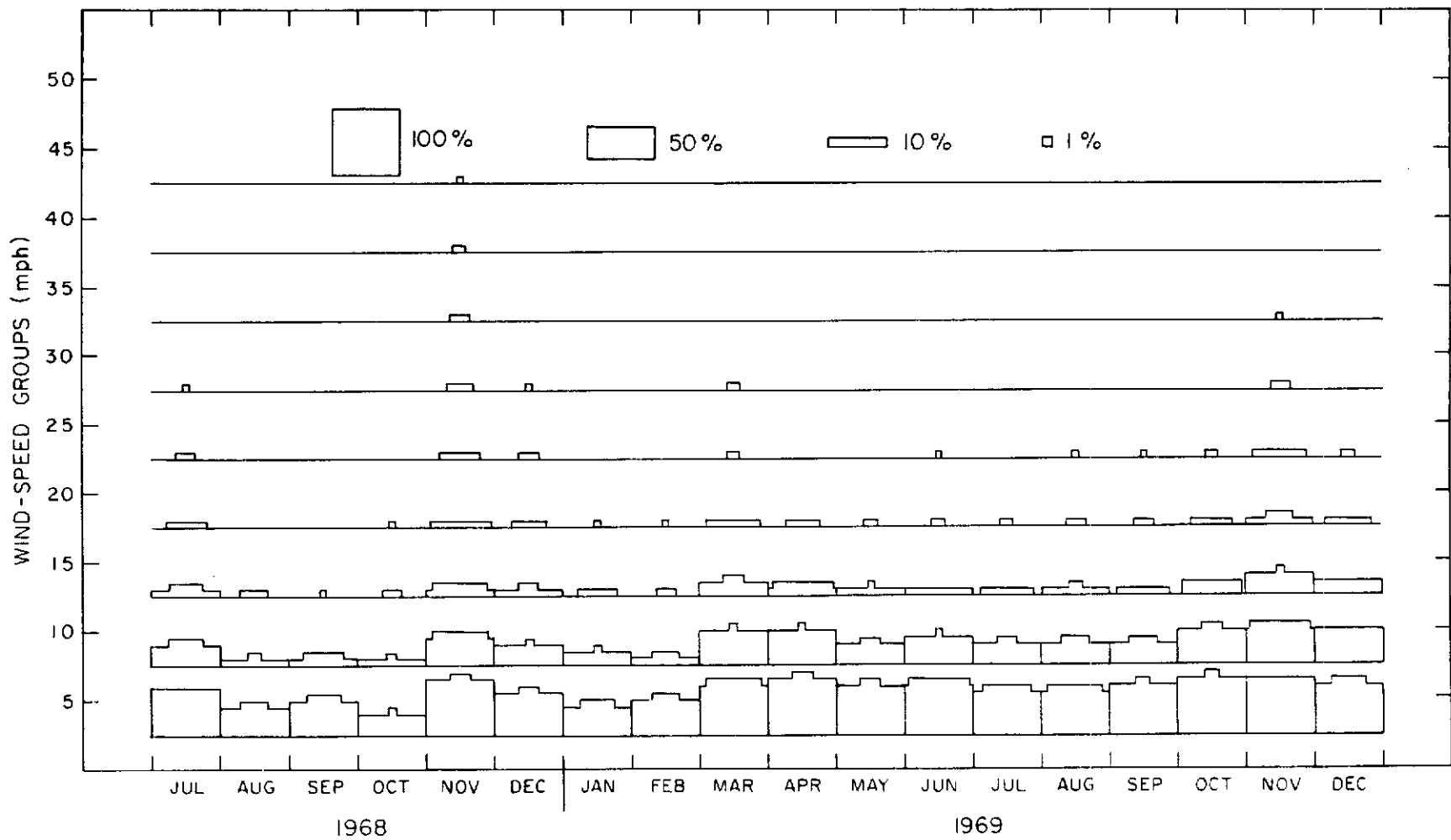


Figure 13. Percent of time the wind speed at knoll #1 exceeded 5-mph incremental wind-speed groups, on a monthly basis.

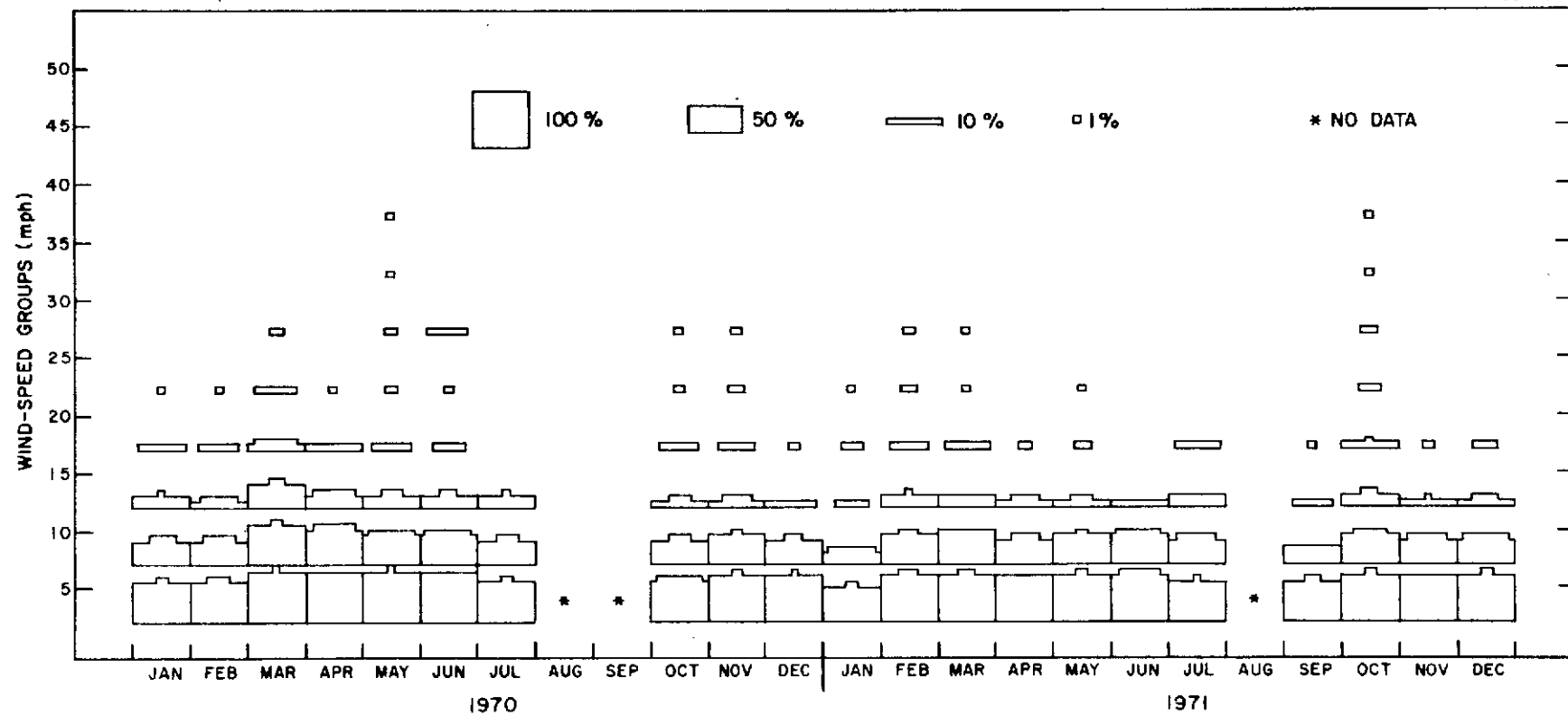


Figure 13 (Cont.)

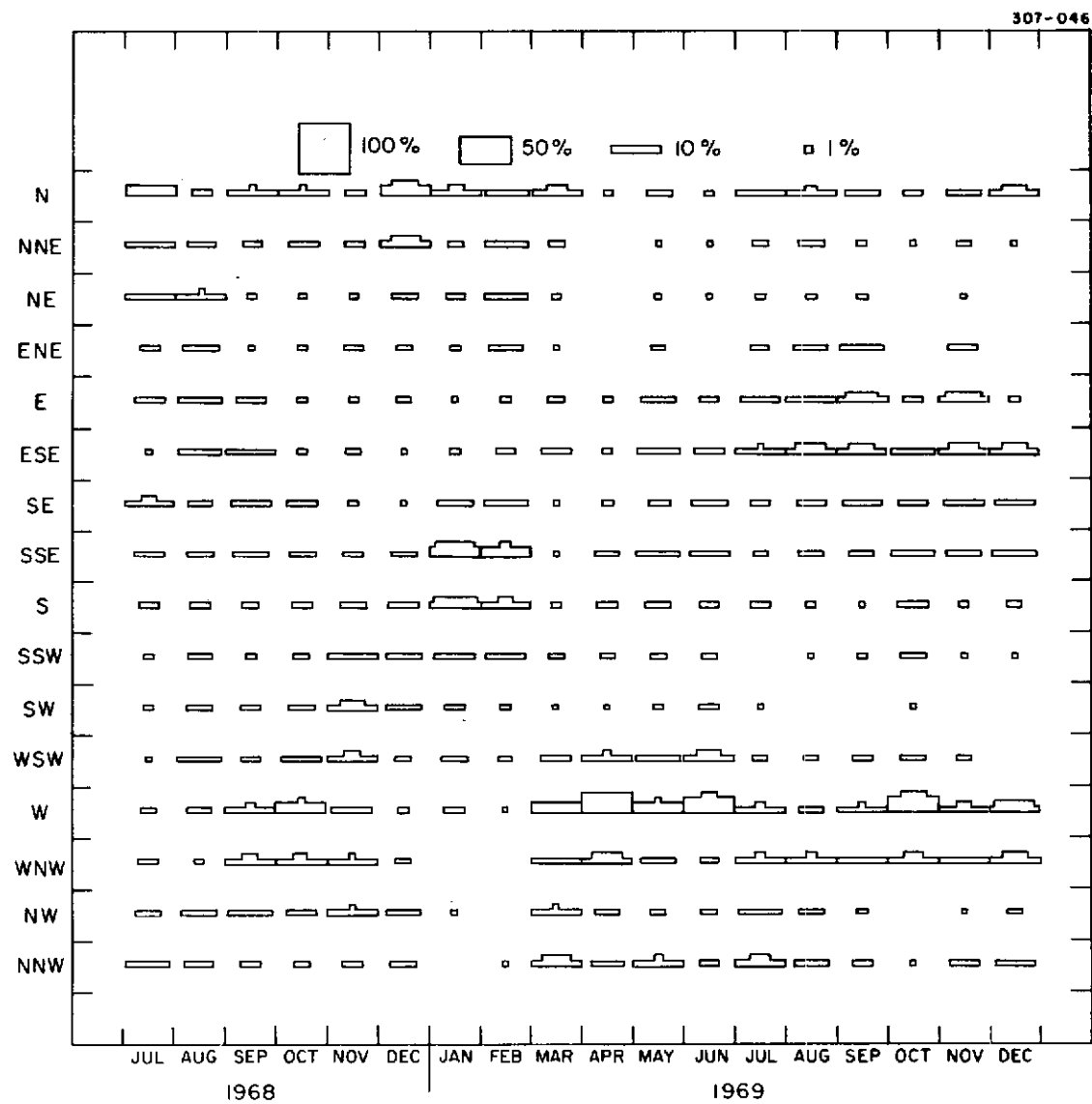


Figure 14. Distribution of wind direction at knoll #1, expressed as a percentage of monthly time.

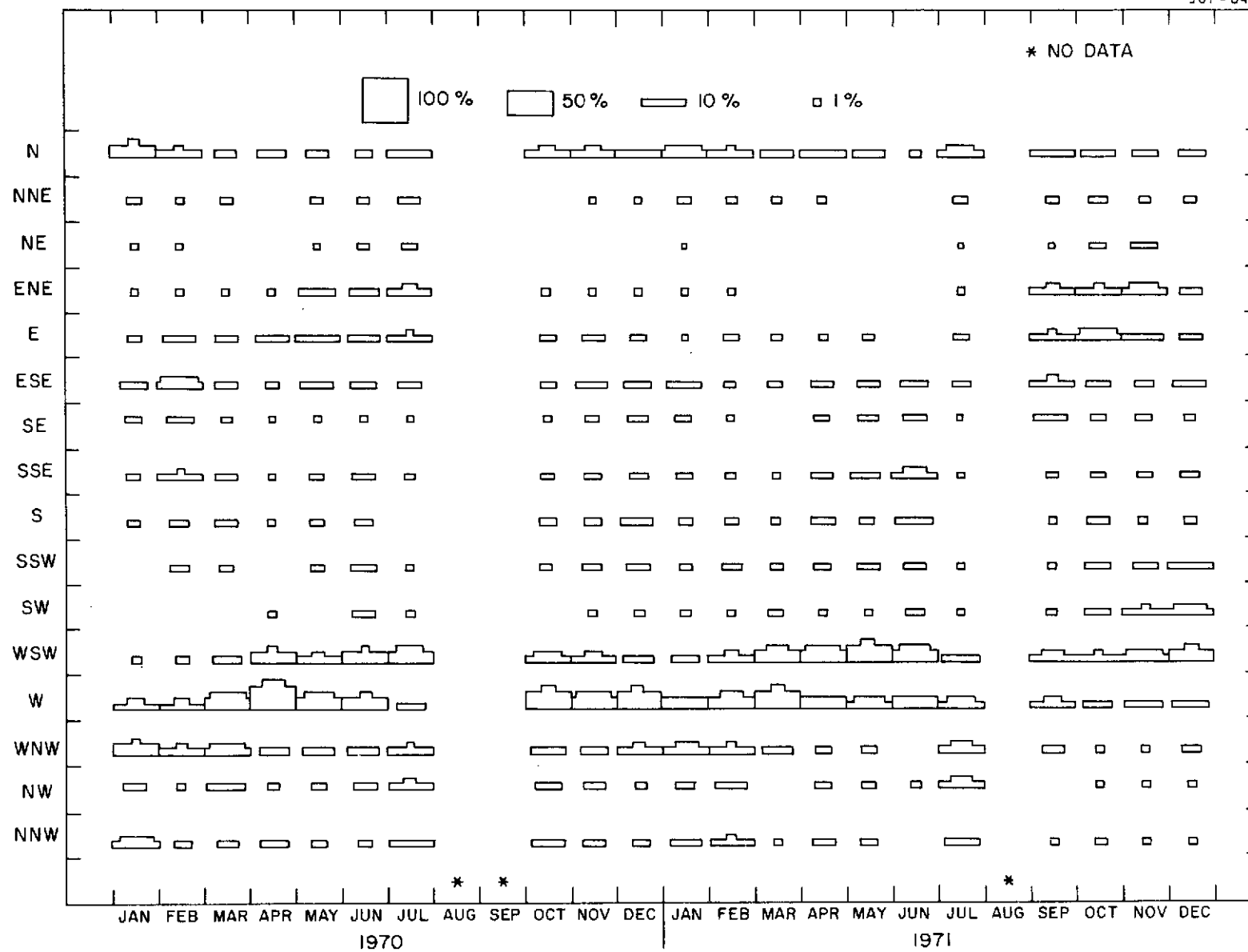


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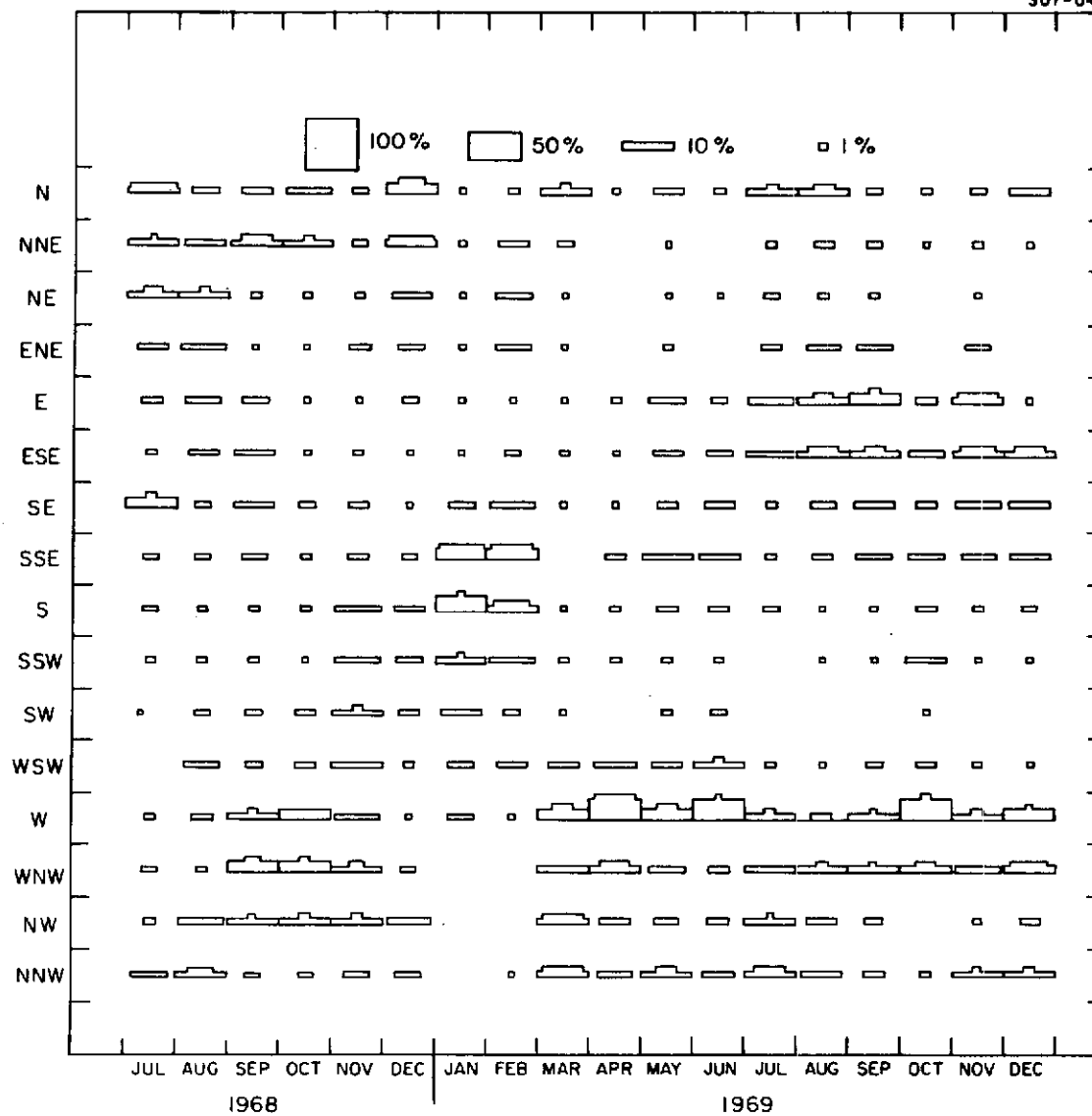


Figure 15. Distribution of wind direction at knoll #1 weighted by speed, expressed as a percentage of monthly time.

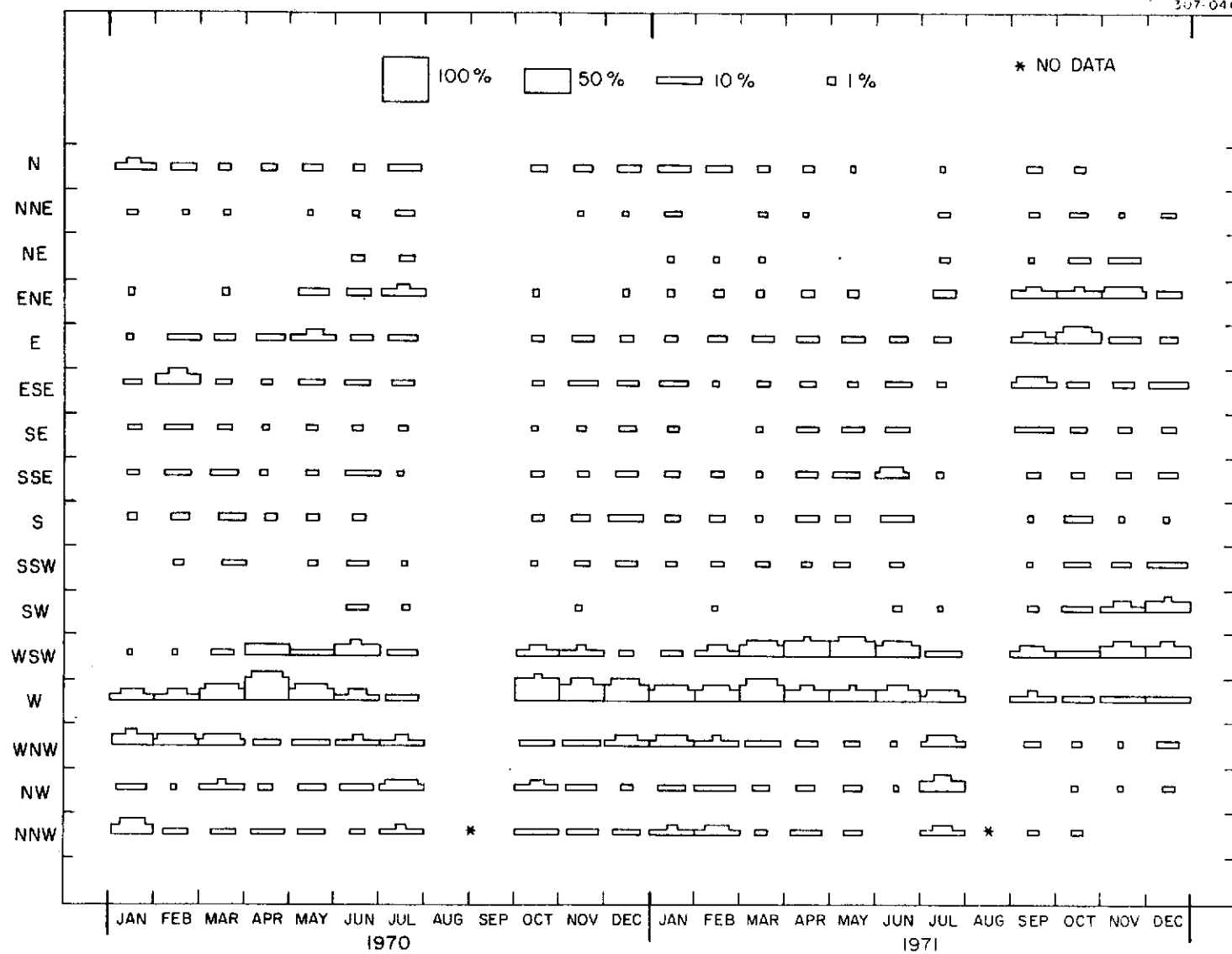


Figure 15 (Cont.)

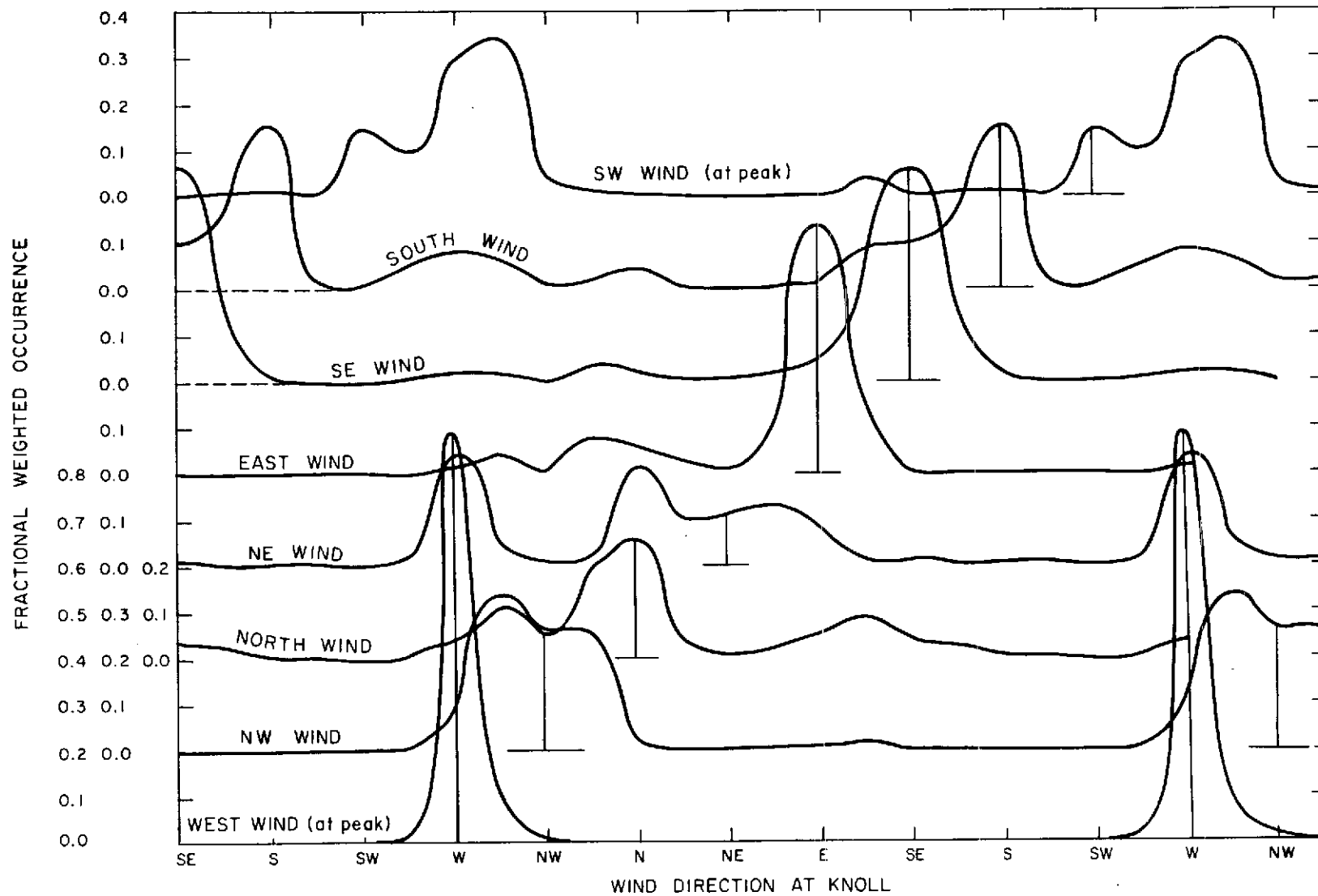


Figure 16. Relative distribution of wind direction at knoll #1, weighted by speed and referred to summit wind direction, July to December 1969.

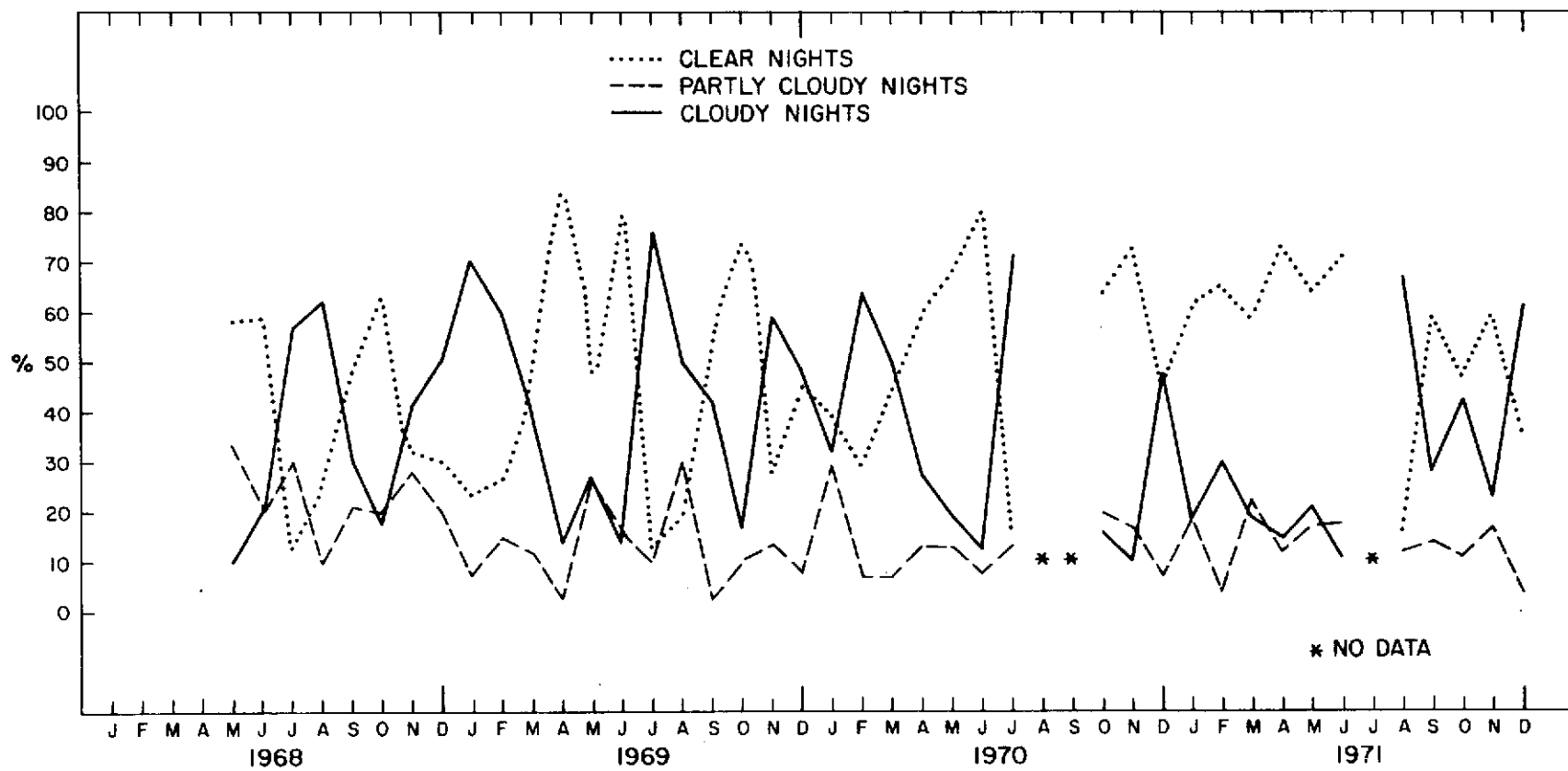


Figure 17. Occurrence of cloud-cover conditions; percentage of nights per month.

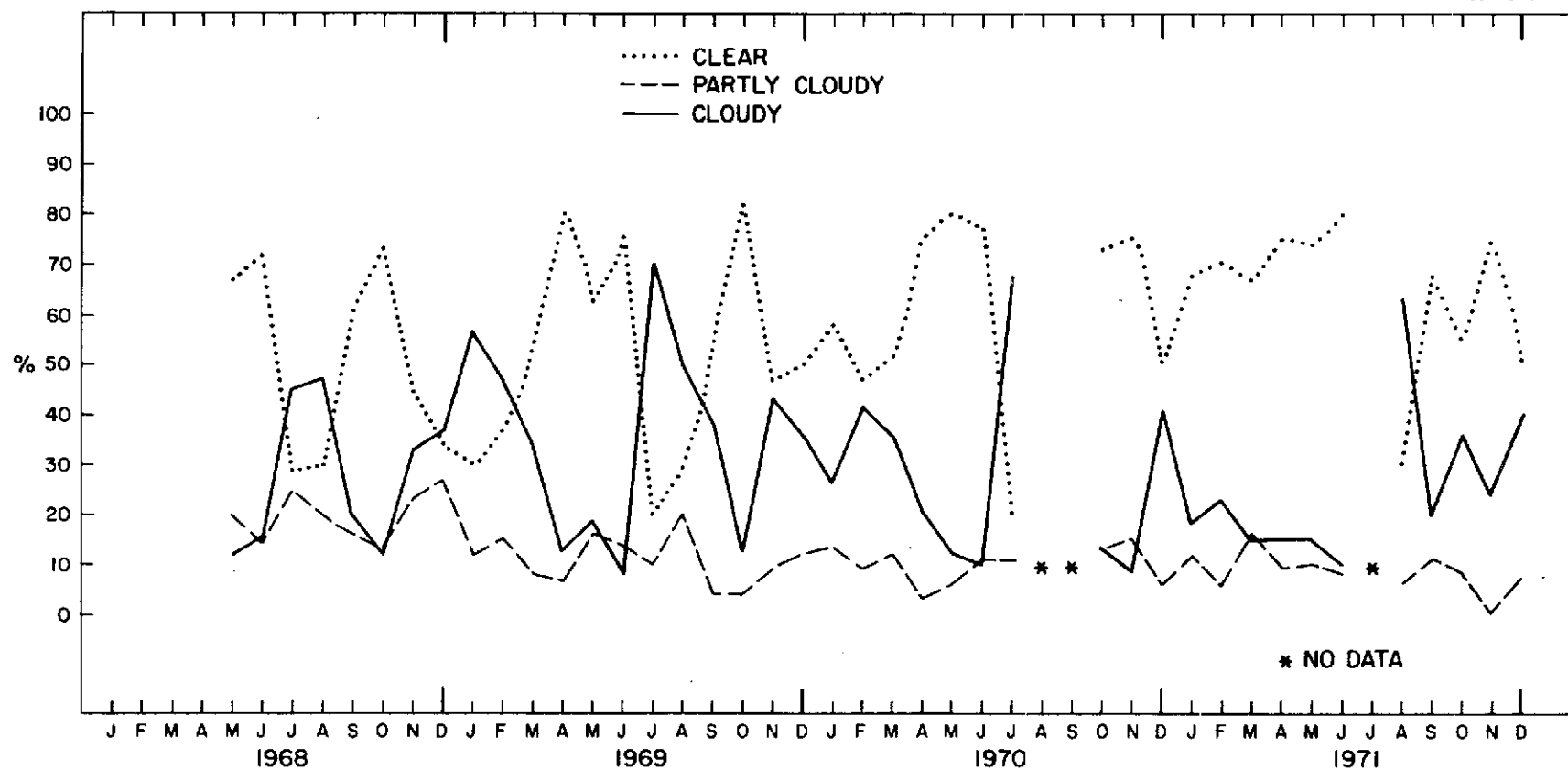


Figure 18. Occurrence of cloud cover during the nighttime hours (7 pm to 5 am), in monthly percentages.

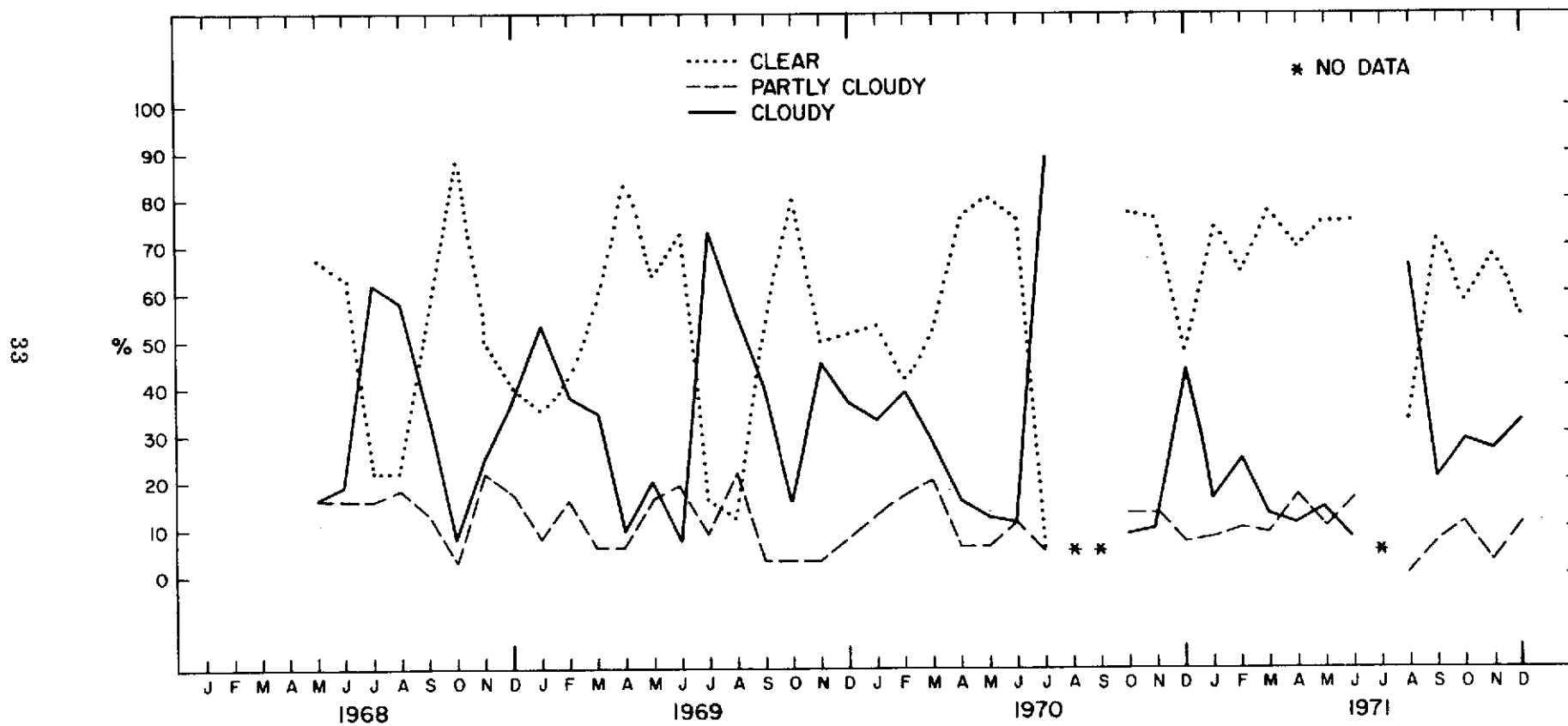


Figure 19. Cloud occurrence at 9 pm, in monthly percentages.

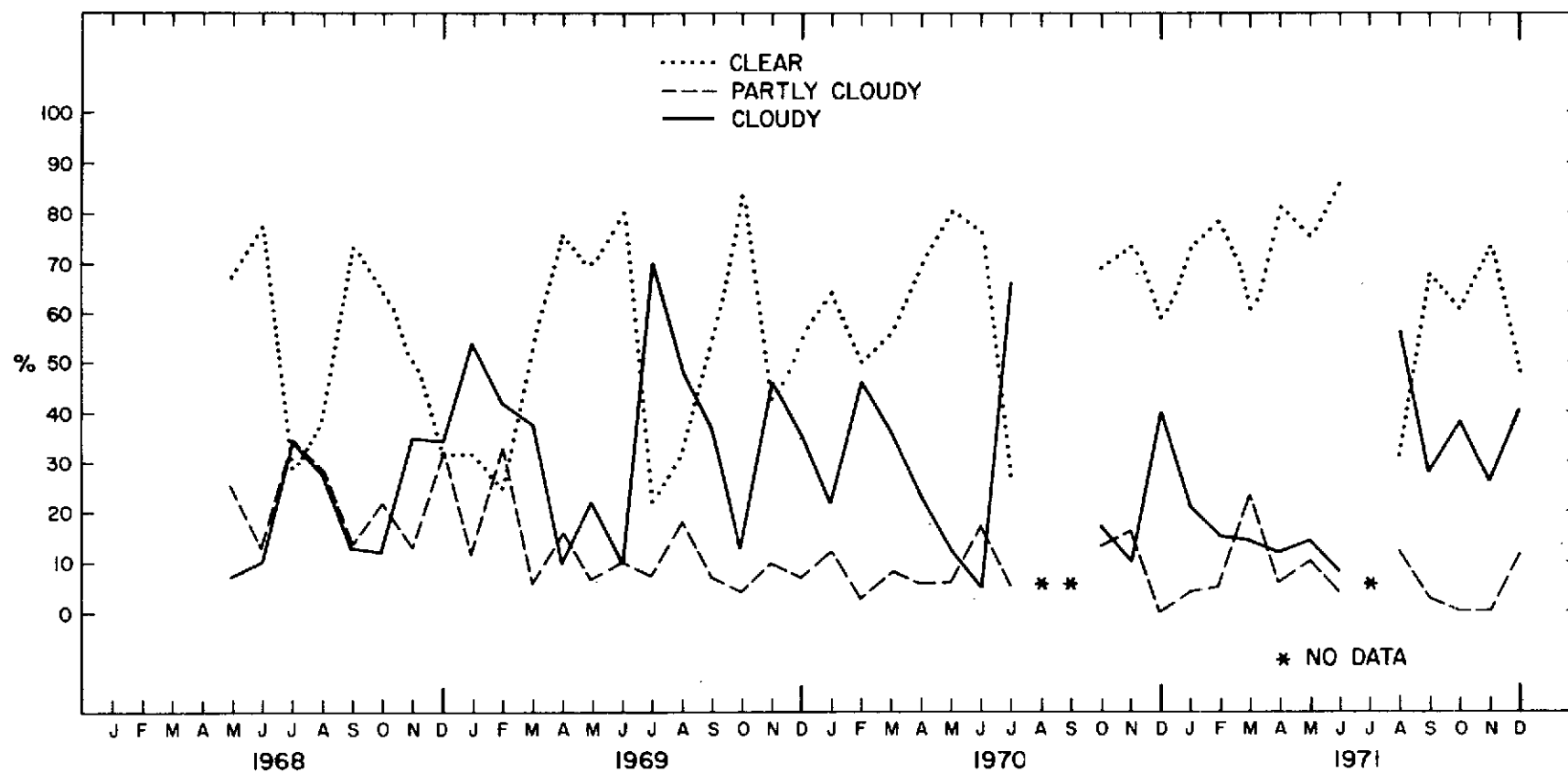


Figure 20. Cloud occurrence at 3 am, in monthly percentages.

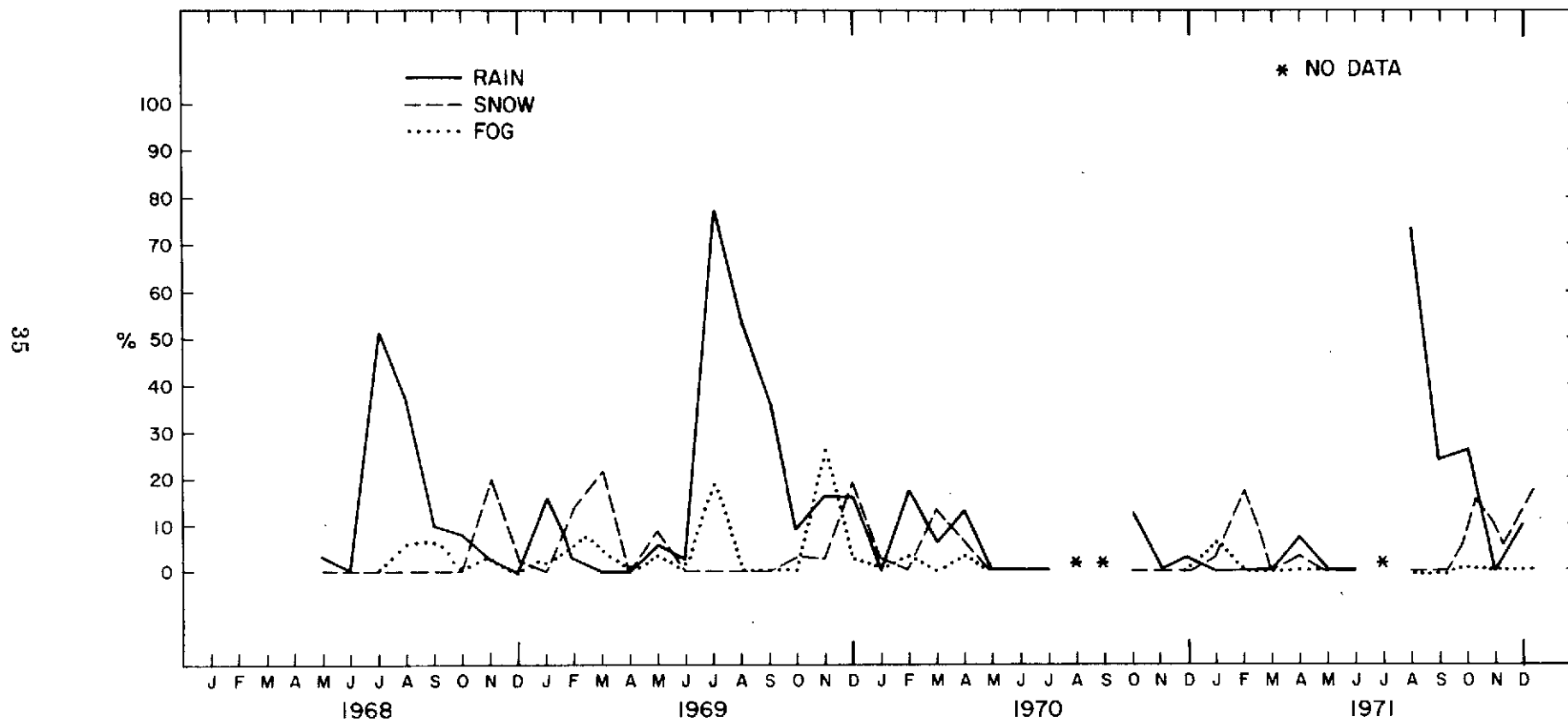


Figure 21. Occurrence of meteorological conditions, in percentage of nights per month.

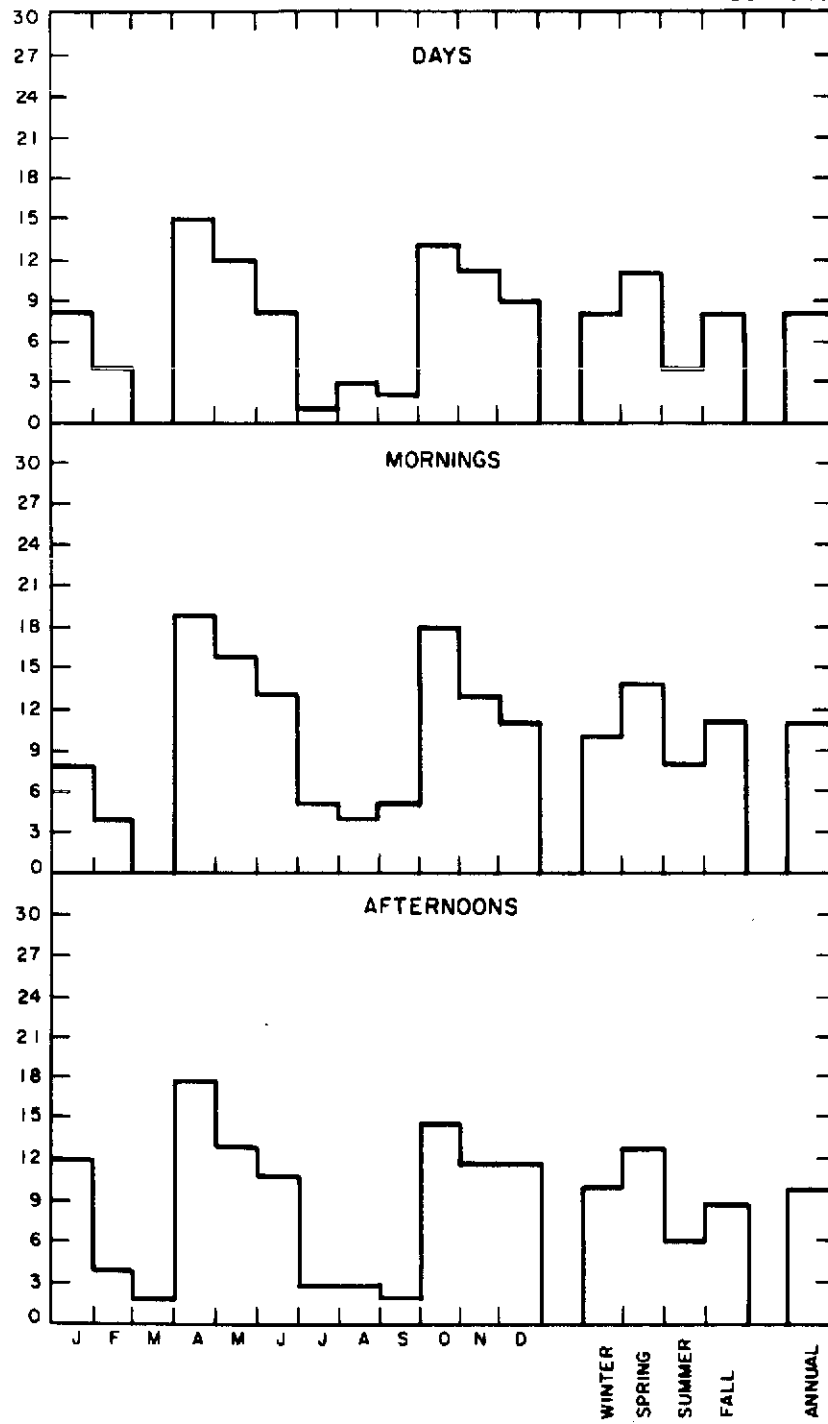


Figure 22a. Mean number of days per month with a clear line of sight from the summit to the sun throughout all daylight hours, October 1967 to September 1968.

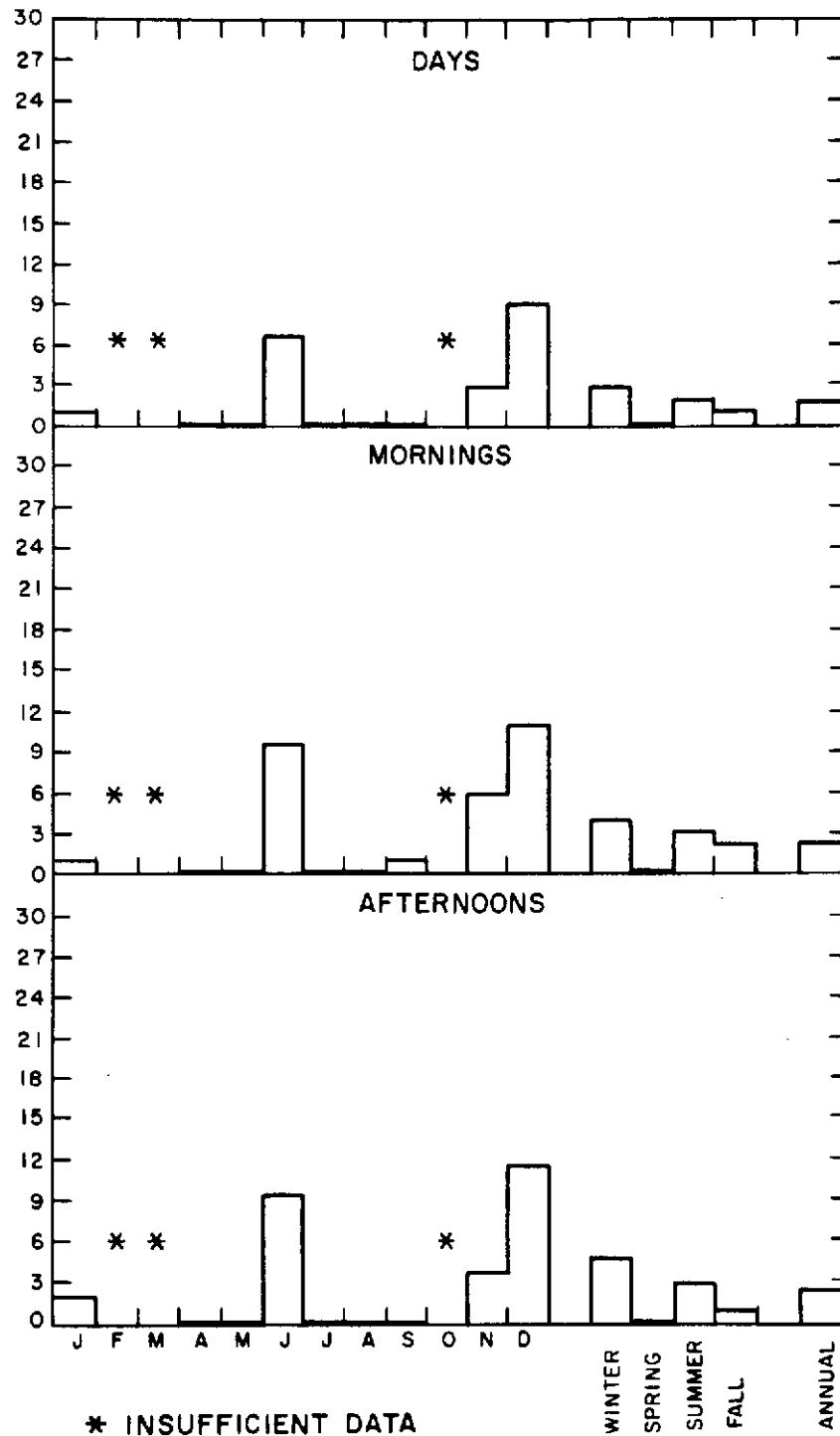


Figure 22b. Mean number of days per month with a clear line of sight from the summit to the sun throughout all daylight hours, December 1968 to November 1969.

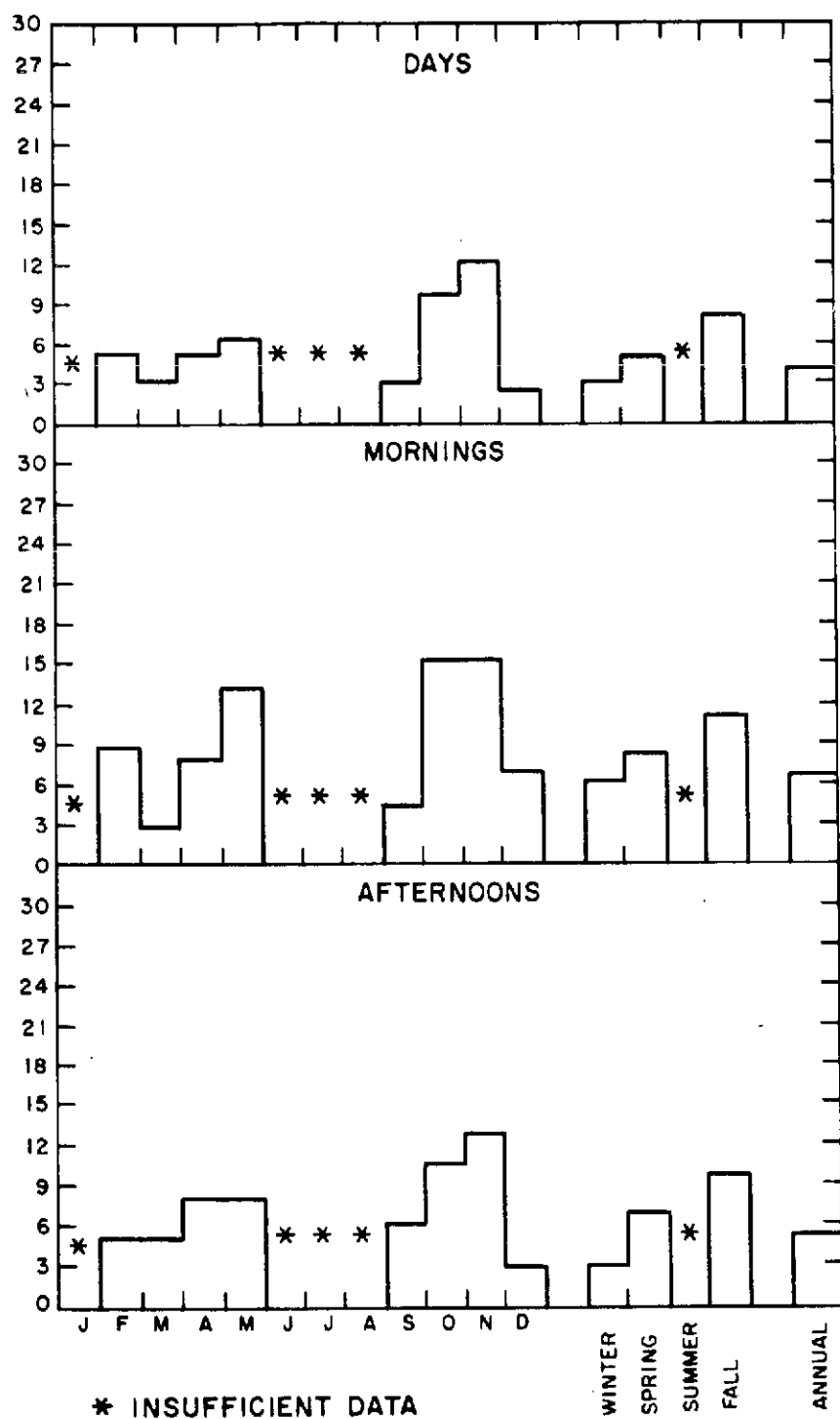


Figure 22c. Mean number of days per month with a clear line of sight from the summit to the sun throughout all daylight hours, December 1969 to November 1970.

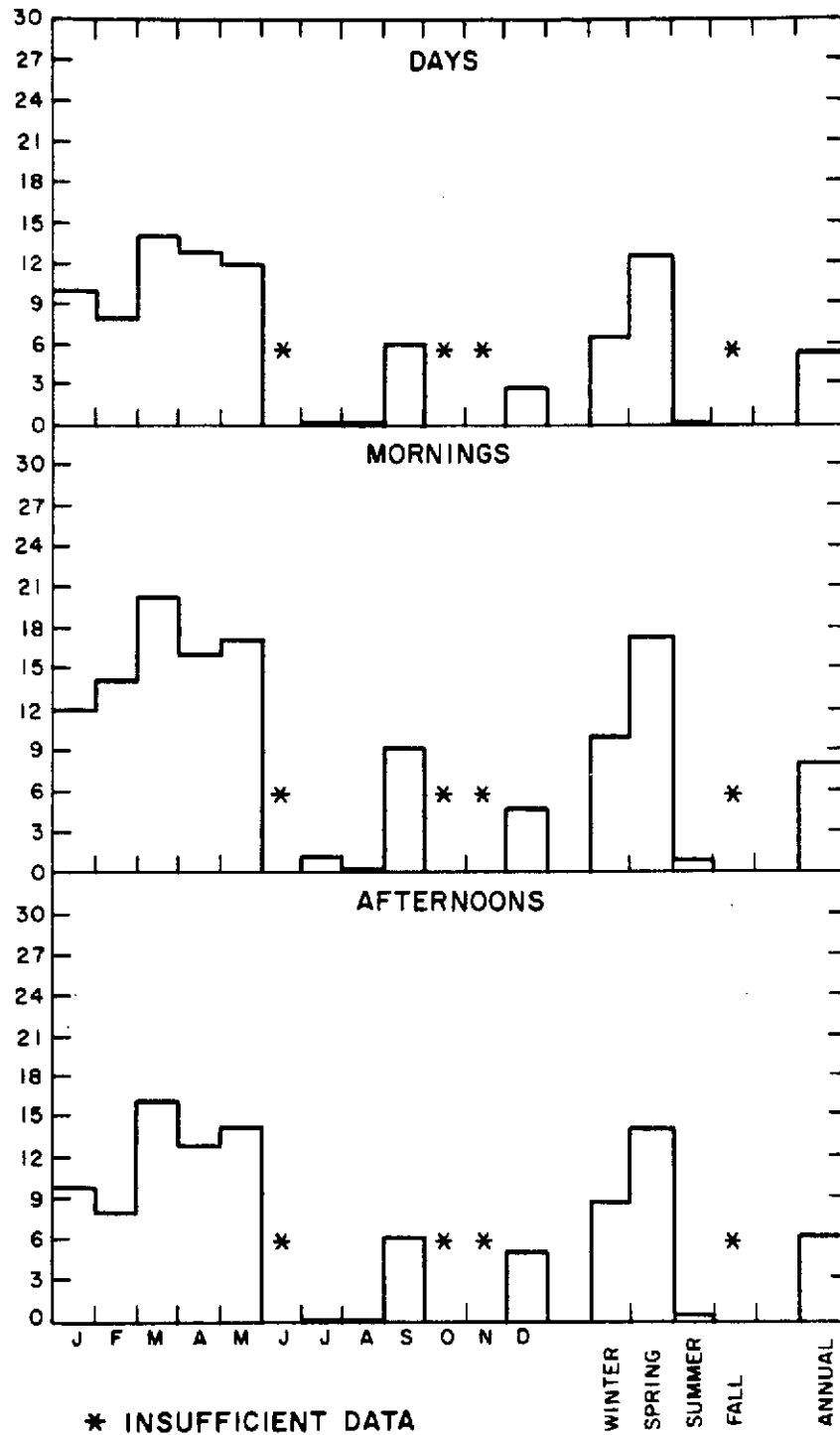


Figure 22d. Mean number of days per month with a clear line of sight from the summit to the sun throughout all daylight hours, December 1970 to November 1971.

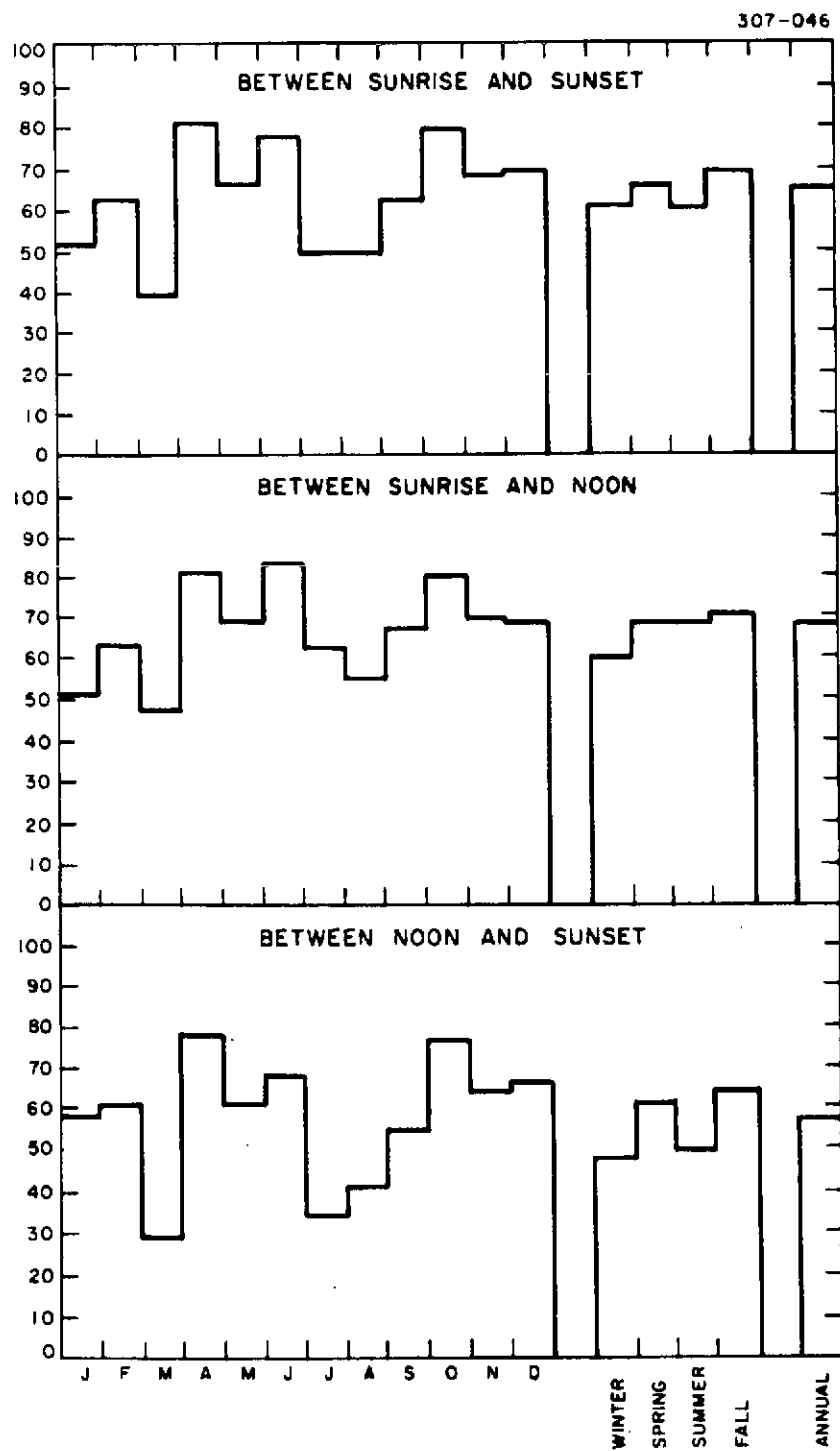


Figure 23a. Mean percentage of 10-min periods with a clear line of sight from the summit to the sun at given periods, October 1967 to September 1968.

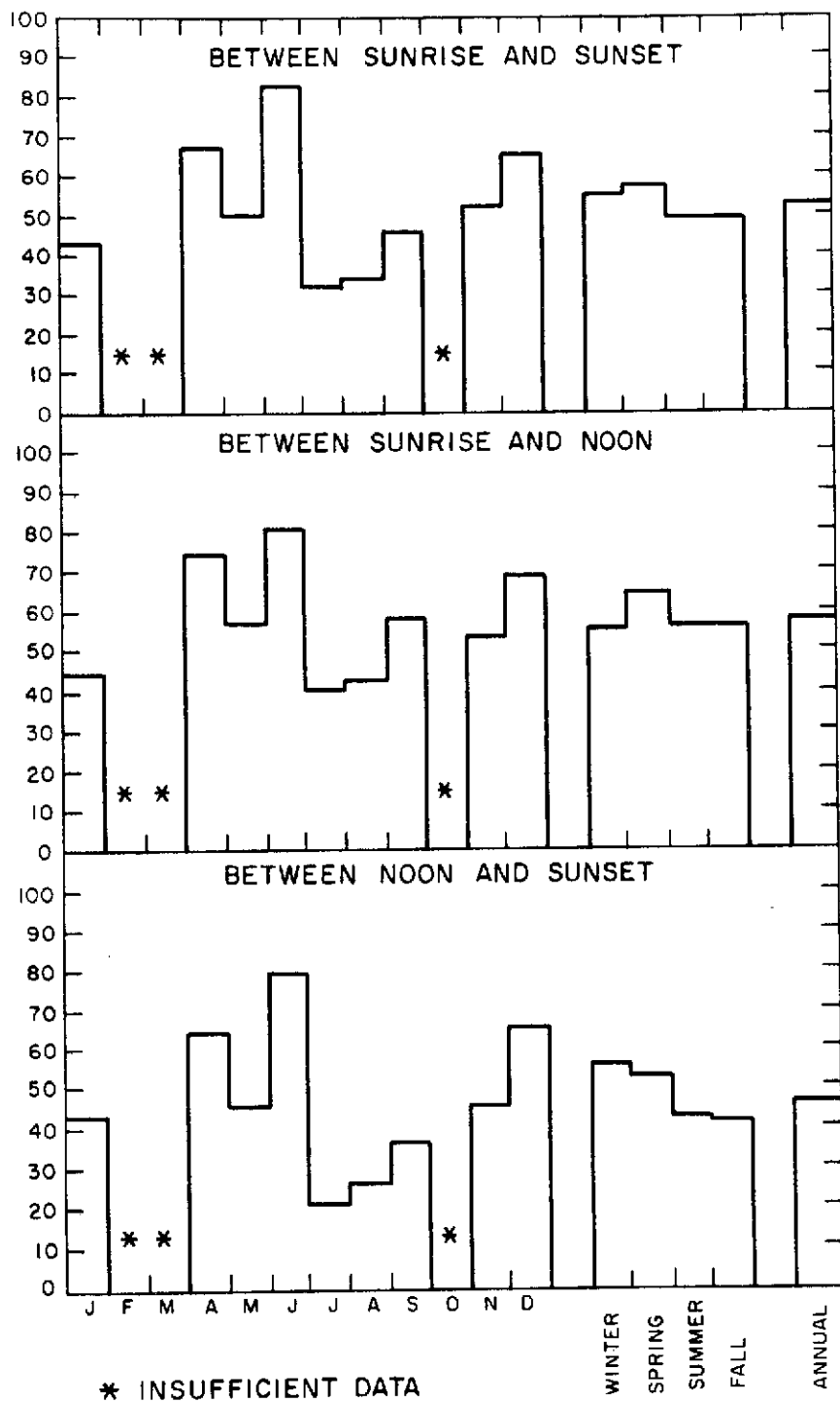


Figure 23b. Mean percentage of 10-min periods with a clear line of sight from the summit to the sun at given periods, December 1968 to November 1969.

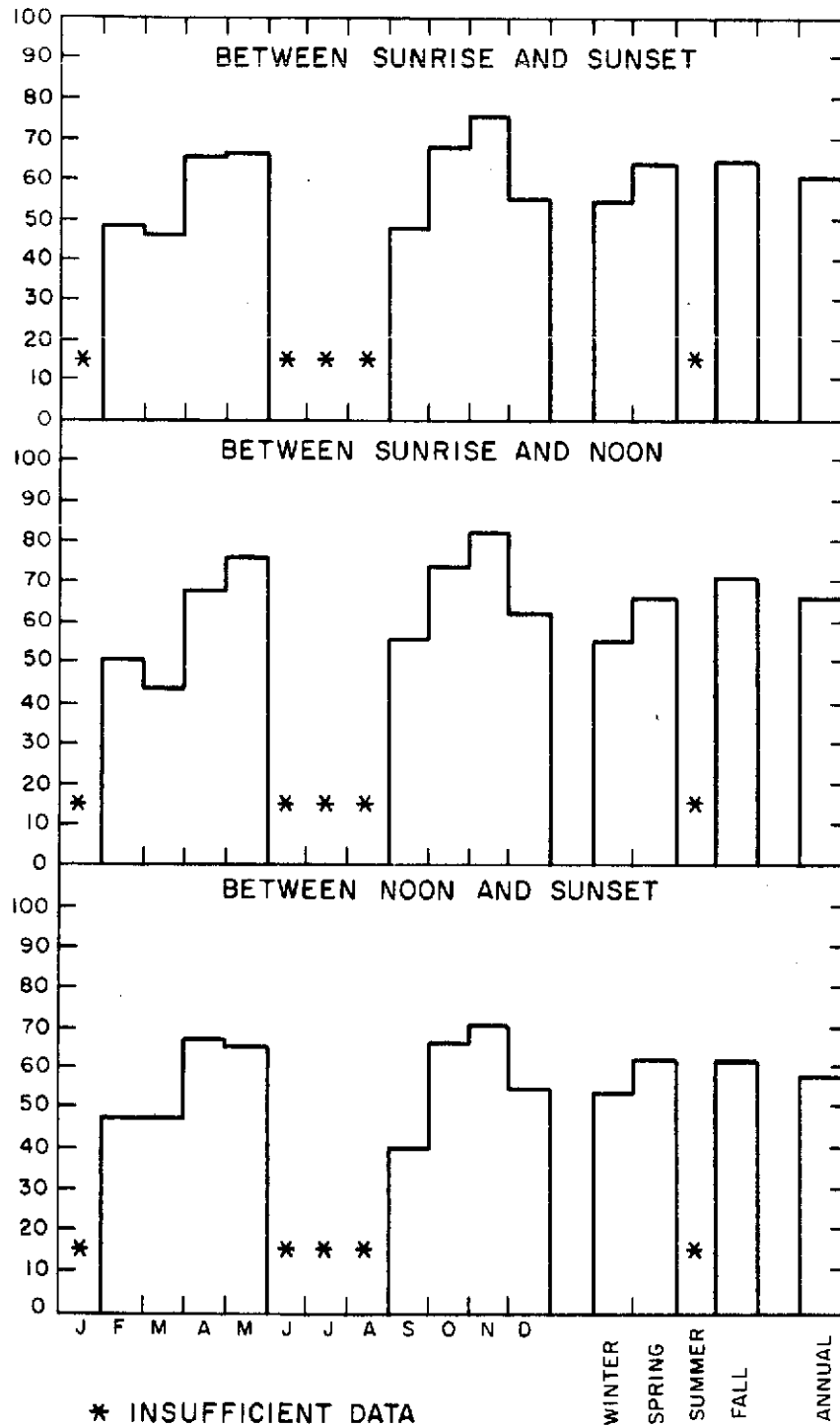


Figure 23c. Mean percentage of 10-min periods with a clear line of sight from the summit to the sun at given periods, December 1969 to November 1970.

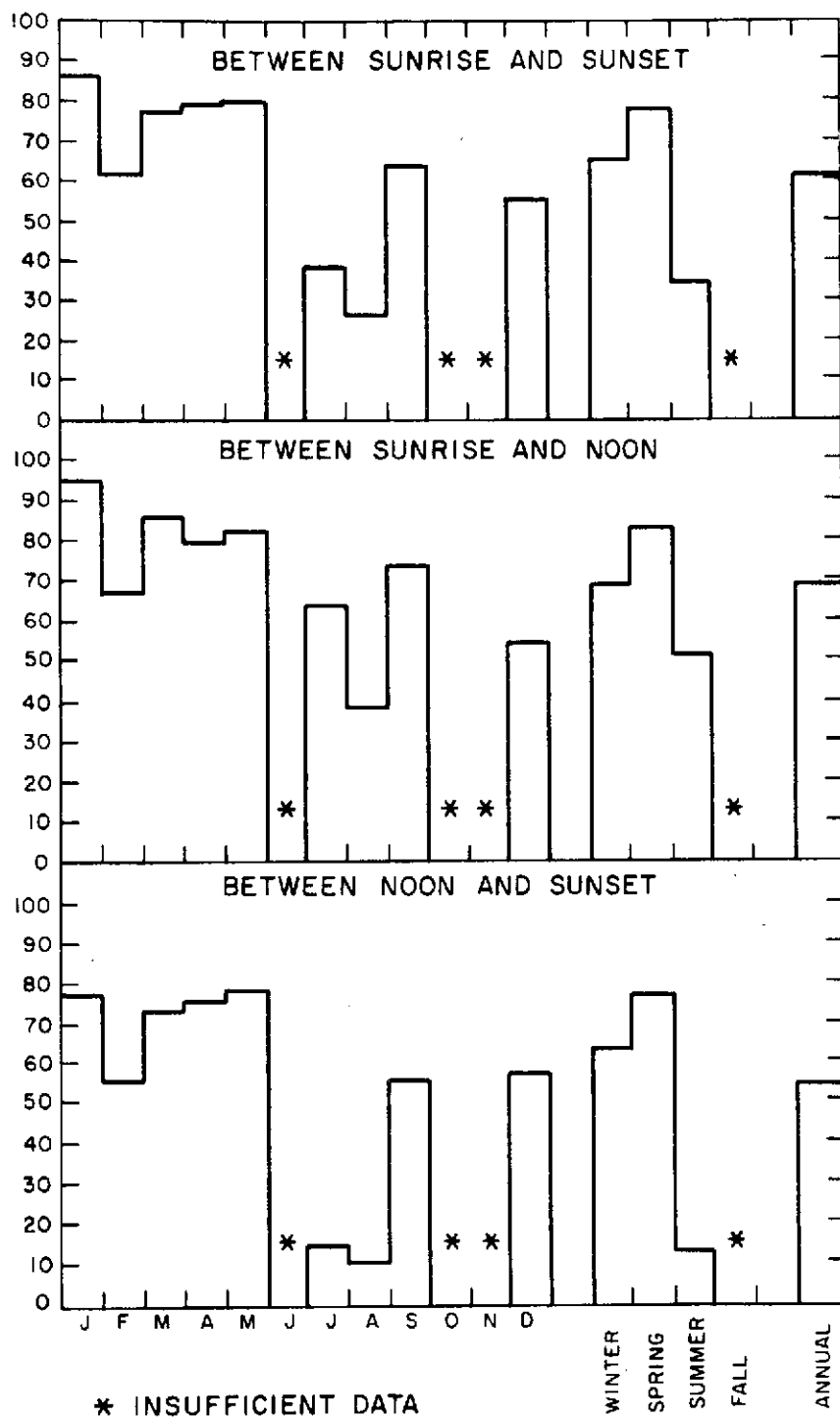


Figure 23d. Mean percentage of 10-min periods with a clear line of sight from the summit to the sun at given periods, December 1970 to November 1971.

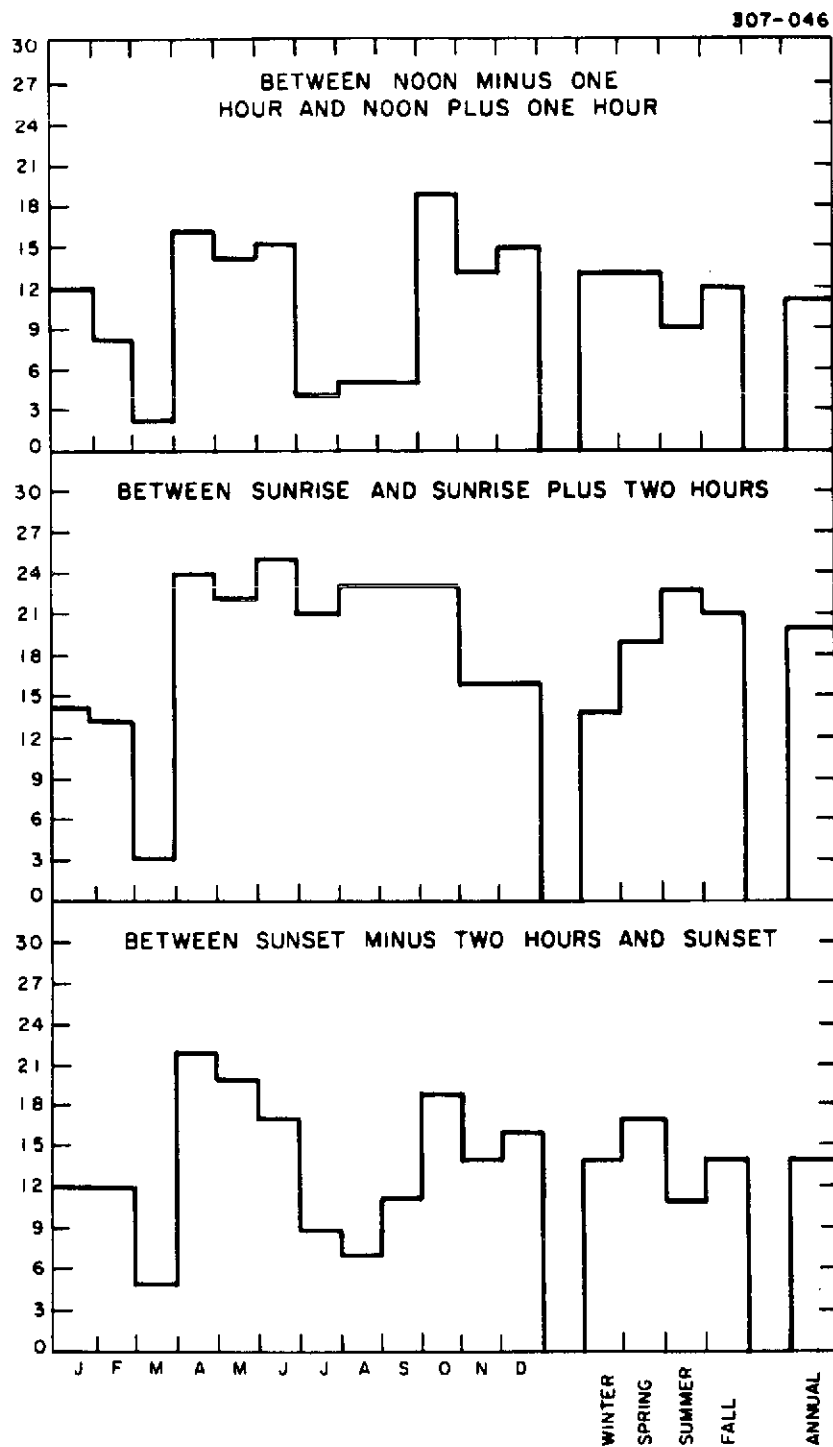


Figure 24a. Mean number of days per month with a clear line of sight from the summit to the sun, October 1967 to September 1968.

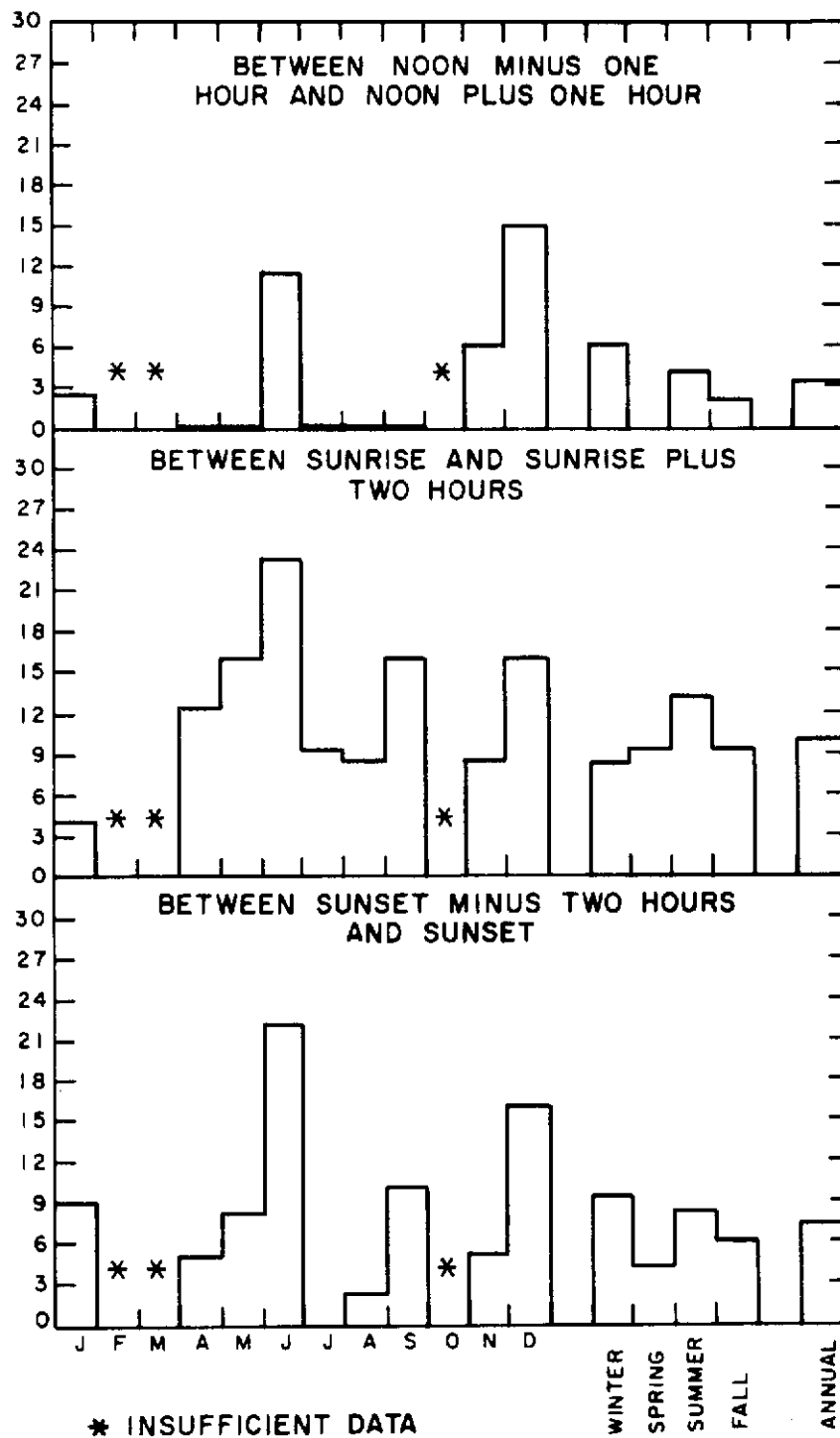


Figure 24b. Mean number of days per month with a clear line of sight from the summit to the sun, December 1968 to November 1969.

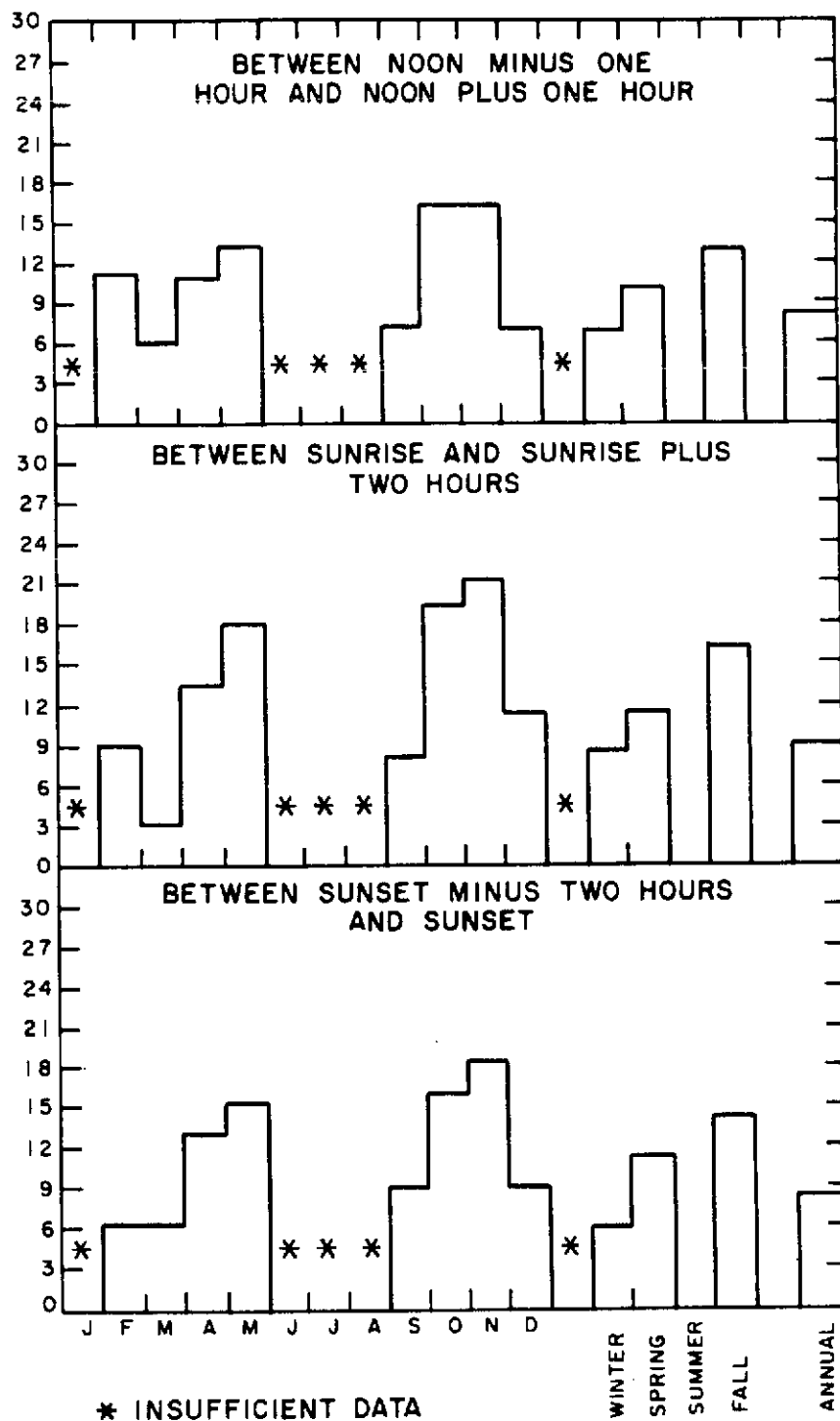


Figure 24c. Mean number of days per month with a clear line of sight from the summit to the sun, December 1969 to November 1970.

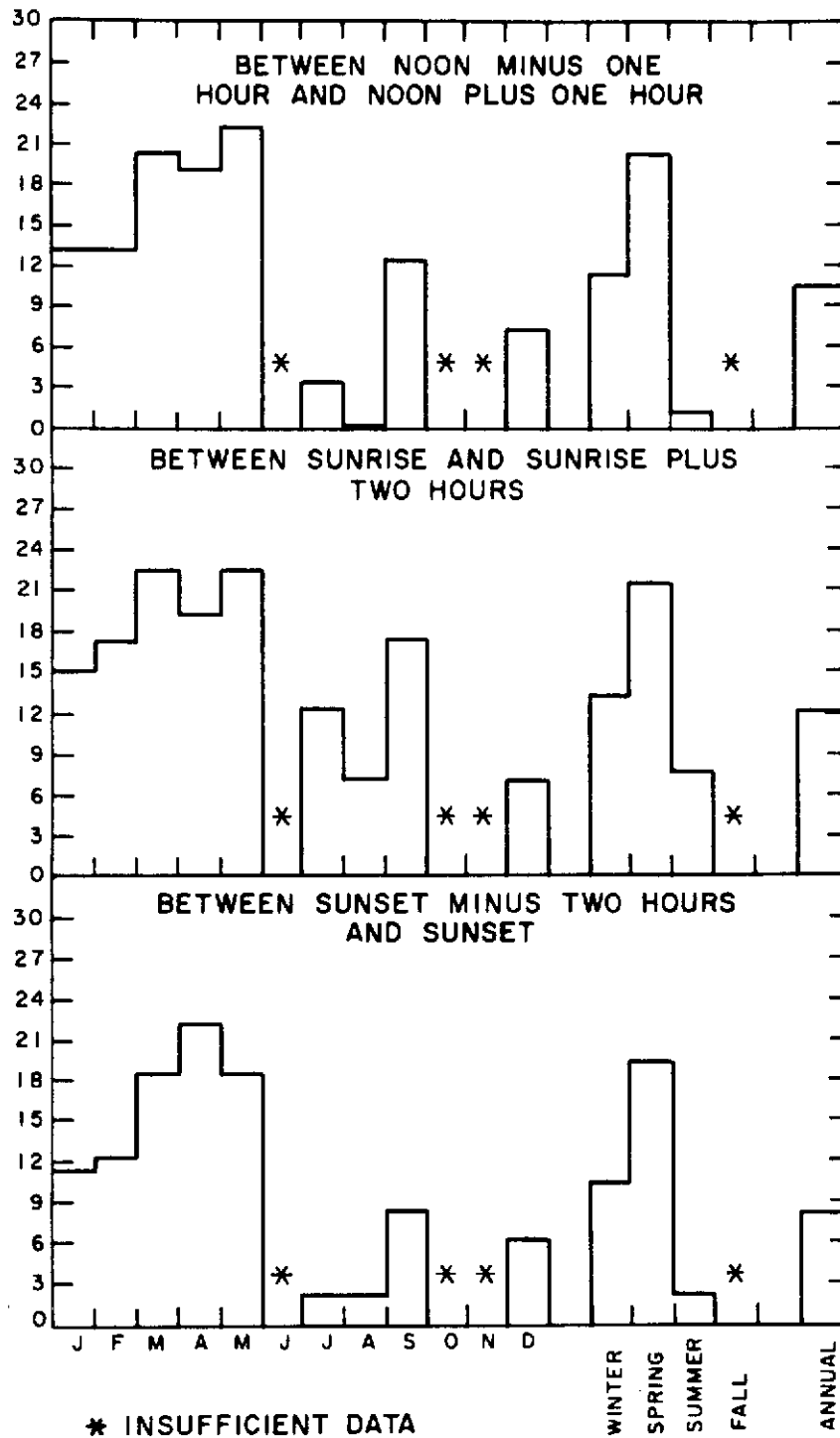


Figure 24d. Mean number of days per month with a clear line of sight from the summit to the sun, December 1970 to November 1971.

DURATION OF PERIODS OF A CLEAR LINE OF SIGHT TO THE SUN		J	F	M	A	M	J	J	A	S	O	N	D		WINTER	SPRING	SUMMER	FALL		ANNUAL
	10 MIN	7	1	13	11	7	22	32	34	45	27	15	6		14	31	88	87		220
	20 MIN	4	3	5	6	6	12	12	12	23	13	6	4		11	17	36	42		106
	30 MIN	7	1	6	3	6	4	5	12	14	9	3	4		12	15	21	26		74
	40 MIN	3	5	4	2	6	7	4	4	13	4	2	5		13	12	15	19		59
	50 MIN	1	1	3	0	0	3	7	4	3	5	5	2		4	3	14	13		34
	01:00 TO 01:50	7	5	9	4	7	14	15	14	22	18	8	6		18	20	43	48		129
	02:00 TO 02:50	4	2	3	2	1	4	10	9	10	7	1	2		8	6	23	18		55
	03:00 TO 03:50	2	1	3	2	6	8	7	6	6	5	2	2		5	11	21	13		50
	04:00 TO 05:50	3	3	2	7	4	7	4	4	14	6	1	3		9	13	15	21		58
	06:00 TO 07:50	2	0	1	3	4	6	5	0	1	4	6	1		3	8	11	11		33
	08:00 TO 09:50	7	0	0	0	1	4	1	1	1	0	4	9		16	1	6	5		28
NUMBER OF DAYS WITH USEFUL DATA	29	7	13	22	30	30	27	23	30	31	30	29		65	65	80	91		301	

Figure 25a. Frequency of occurrence of a clear line of sight from the summit to the sun for periods of specified durations, October 1967 to September 1968.

DURATION OF PERIODS OF A CLEAR LINE OF SIGHT TO THE SUN		J	F	M	A	M	J	J	A	S	O	N	D		WINTER	SPRING	SUMMER	FALL		ANNUAL
	10 MIN	8	0	0	43	73	30	47	56	45	1	6	23		31	116	133	52		332
	20 MIN	10	4	0	31	36	7	35	28	20	6	11	12		26	67	70	37		200
	30 MIN	5	2	0	23	30	12	17	25	18	2	4	8		15	53	54	24		146
	40 MIN	10	1	0	18	21	10	12	19	17	7	3	4		15	39	41	27		112
	50 MIN	2	4	0	17	8	2	15	18	10	3	1	4		10	25	35	14		84
	60 MIN	16	3	0	26	26	18	30	24	20	11	13	17		36	52	72	44		204
	120 MIN	6	2	0	23	15	10	7	7	13	4	2	8		16	38	24	19		97
	180 MIN	3	2	0	9	3	6	0	5	10	1	1	4		9	12	11	12		44
	240 MIN	3	1	0	5	8	14	4	1	5	2	2	3		7	13	19	9		48
	360 MIN	2	0	0	0	2	5	1	0	1	0	0	6		8	2	6	1		17
	480 MIN	1	0	0	0	0	0	0	0	0	0	4	4		5	0	0	4		9
	600 MIN	0	0	0	0	0	2	0	0	0	0	2	3		3	0	2	2		7
	720 MIN OR MORE	2	0	0	0	1	15	0	0	0	0	3	9		11	1	15	3		30
	NUMBER OF DAYS WITH USEFUL DATA	27	8	0	23	30	29	31	30	30	9	19	31		66	53	90	58		267

Figure 25b. Frequency of occurrence of a clear line of sight from the summit to the sun for periods of specified durations, December 1968 to November 1969.

DURATION OF PERIODS OF A CLEAR LINE OF SIGHT TO THE SUN		J	F	M	A	M	J	J	A	S	O	N	D		WINTER	SPRING	SUMMER	FALL		ANNUAL
	10 MIN	1	24	5	2	17	1	0	0	18	10	10	19		44	24	1	38		107
	20 MIN	2	12	3	8	9	0	0	0	7	3	4	15		29	20	0	14		63
	30 MIN	0	10	6	3	6	1	0	0	8	4	3	18		28	15	1	15		59
	40 MIN	0	2	2	0	4	0	0	0	4	3	3	16		18	6	0	10		34
	50 MIN	0	1	0	4	2	2	0	0	1	2	4	11		12	6	2	7		27
	60 MIN	0	11	4	7	6	0	0	0	9	9	8	26		37	17	0	26		80
	120 MIN	0	4	2	2	2	0	0	0	3	8	4	4		8	6	0	15		29
	180 MIN	1	0	1	2	3	0	0	0	6	0	5	11		12	6	0	11		29
	240 MIN	0	1	2	7	8	4	0	0	3	6	7	2		3	17	4	16		40
	360 MIN	0	0	2	4	7	0	0	0	2	3	0	4		4	13	0	5		22
	480 MIN	1	3	0	1	4	0	0	0	0	3	6	0		4	5	0	9		18
	600 MIN	2	5	3	2	0	0	0	0	5	10	9	2		9	5	0	24		38
	720 MIN OR MORE	2	7	3	10	13	0	0	0	3	10	12	2		11	26	0	25		62
	NUMBER OF DAYS WITH USEFUL DATA	4	28	15	22	28	2	0	0	25	31	30	30		62	65	2	86		215

Figure 25c. Frequency of occurrence of a clear line of sight from the summit to the sun for periods of specified durations, December 1969 to November 1970.

DURATION OF PERIODS OF A CLEAR LINE OF SIGHT TO THE SUN	J	F	M	A	M	J	J	A	S	O	N	D	WINTER	SPRING	SUMMER	FALL	ANNUAL
10 MIN	2	9	4	16	15	0	32	25	21	2	0	6	17	35	57	23	132
20 MIN	2	6	2	8	5	0	22	16	14	0	0	3	11	15	38	14	78
30 MIN	1	3	3	4	4	0	5	5	11	0	0	0	4	11	10	11	36
40 MIN	0	5	0	6	7	0	12	7	7	0	0	3	8	13	19	7	47
50 MIN	2	1	1	3	3	0	6	7	4	2	0	0	3	7	13	6	29
60 MIN	2	10	7	6	7	0	19	24	12	1	0	2	14	20	43	13	90
120 MIN	2	4	7	7	3	0	11	11	6	0	0	3	9	17	22	6	54
180 MIN	0	4	0	3	2	0	3	1	2	1	0	3	7	5	4	3	19
240 MIN	3	1	4	5	7	0	7	2	9	0	0	3	7	16	9	9	41
360 MIN	2	2	3	3	1	0	3	0	2	0	0	2	6	7	3	2	18
480 MIN	0	3	2	3	6	0	2	0	0	1	0	4	7	11	2	1	21
600 MIN	10	8	7	0	2	0	0	0	1	1	0	0	18	9	0	2	29
720 MIN OR MORE	11	8	23	26	25	2	0	0	12	1	0	3	22	74	2	13	111
NUMBER OF DAYS WITH USEFUL DATA	18	28	30	30	30	2	31	29	21	4	0	17	63	90	62	25	240

Figure 25d. Frequency of occurrence of a clear line of sight from the summit to the sun for periods of specified durations, December 1970 to November 1971.

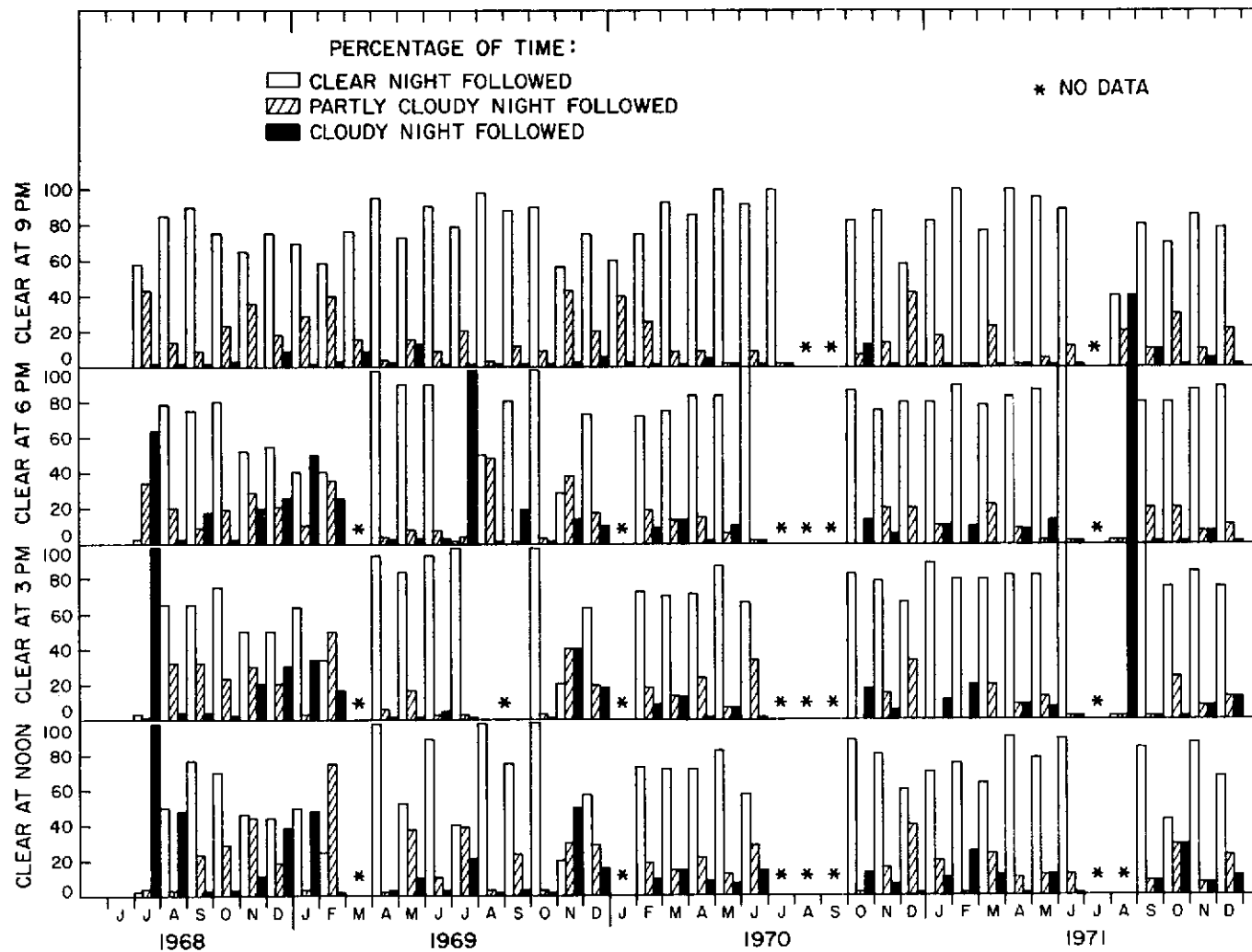


Figure 26. Correlation of nighttime sky conditions with observed clear skies during the preceding day at times shown.

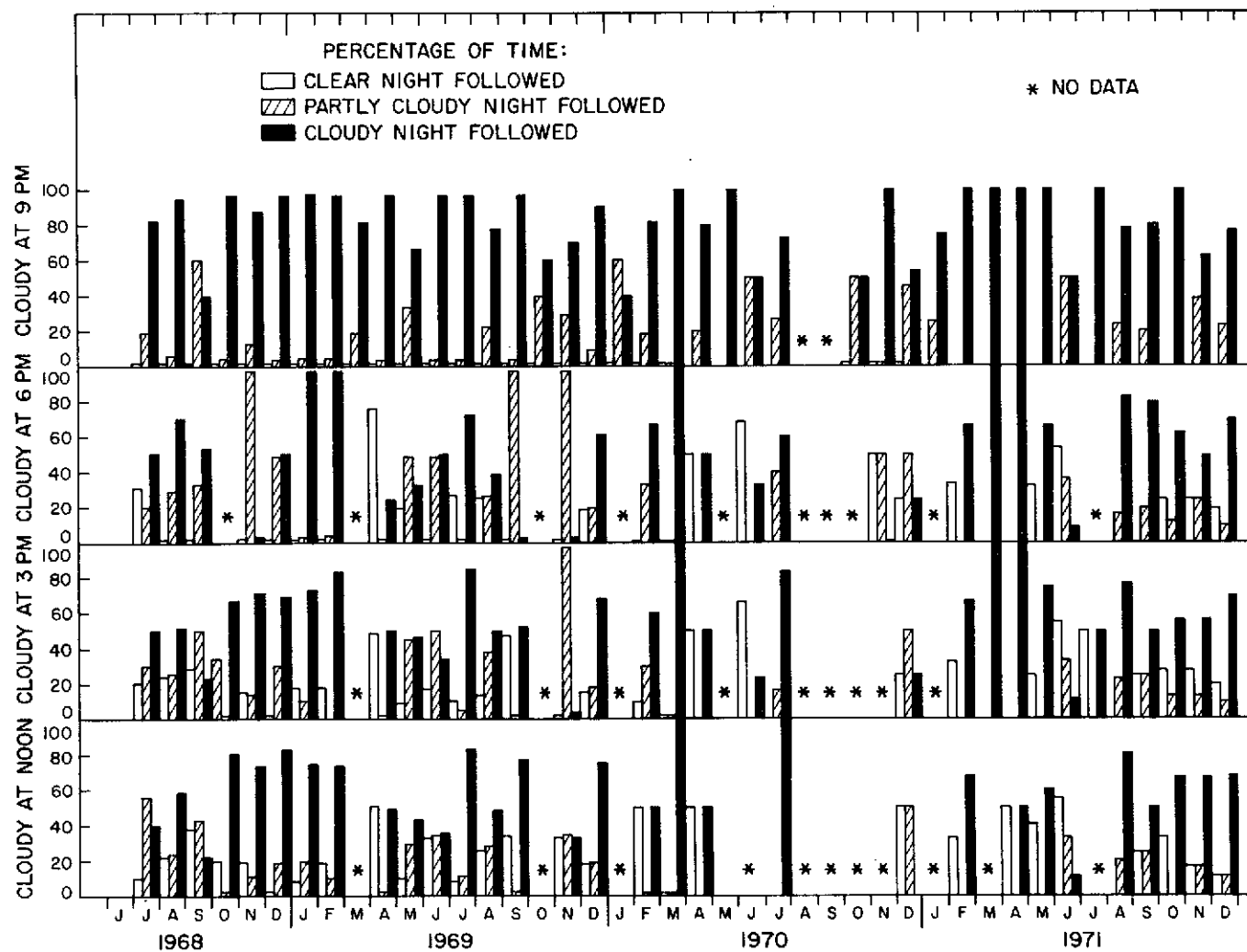


Figure 27. Correlation of nighttime sky conditions with observed cloudy skies during the preceding day at times shown.

BIOGRAPHICAL NOTES

MICHAEL R. PEARLMAN received his B.S. in physics from the Massachusetts Institute of Technology in 1963 and his Ph.D. in physics from Tufts University in 1968.

Dr. Pearlman joined the staff of Smithsonian Astrophysical Observatory in September 1968 as a scientist in the Satellite Geophysics Group. From February 1971 to July 1972, he was a Visiting Scientist in the Office of Geodetic Satellites at the National Aeronautics and Space Administration Headquarters in Washington, D. C. Since July 1972, Dr. Pearlman has been Chief of the Experimental Geophysics Department in the Observatory's Earth Dynamics Program. He is currently working primarily on laser satellite tracking.

DONALD HOGAN received a B.S. degree in navigation from the Massachusetts Maritime Academy in 1957 and has attended Boston University, the University of New Mexico, and Pima College in Tucson.

Before joining Smithsonian Astrophysical Observatory in 1963, he was Operations Officer in communications and electronics in the Navy. After being on the observing staff at SAO field stations in New Mexico and Iran, Mr. Hogan transferred to Mt. Hopkins in 1967, where he became Manager of the Observer Services Division. In June 1973, he was appointed Support Supervisor of the Mt. Hopkins Observatory.

KENNETH GOODWIN received an Associates Degree in electrical engineering in 1962 from New York State University and has attended New Mexico State University.

Mr. Goodwin joined Smithsonian Astrophysical Observatory in 1962 and has been an observer and EECO timing specialist at SAO field stations in New Mexico, Spain, and Arizona. He has also been a laser leader and has worked on Project Scanner.

In early 1969, Mr. Goodwin joined the Observer Services Division at Mt. Hopkins. He left the Observatory in July 1973.

DeWAYNE KURTENBACH received a B.S. degree in mathematics and electronics from Southern State College in Springfield, South Dakota, in 1961. He has also attended the University of Arizona and Pima College in Tucson.

Before coming to the Smithsonian Astrophysical Observatory in 1969, he taught mathematics and electronics at the high-school level.

Mr. Kurtenbach joined the Observer Services Division at Mt. Hopkins in 1969. In June 1973, he transferred to the technical support group at Mt. Hopkins.

NOTICE

This series of Special Reports was instituted under the supervision of Dr. F. L. Whipple, Director of the Astrophysical Observatory of the Smithsonian Institution, shortly after the launching of the first artificial earth satellite on October 4, 1957. Contributions come from the Staff of the Observatory.

First issued to ensure the immediate dissemination of data for satellite tracking, the reports have continued to provide a rapid distribution of catalogs of satellite observations, orbital information, and preliminary results of data analyses prior to formal publication in the appropriate journals. The Reports are also used extensively for the rapid publication of preliminary or special results in other fields of astrophysics.

The Reports are regularly distributed to all institutions participating in the U. S. space research program and to individual scientists who request them from the Publications Division, Distribution Section, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02138.